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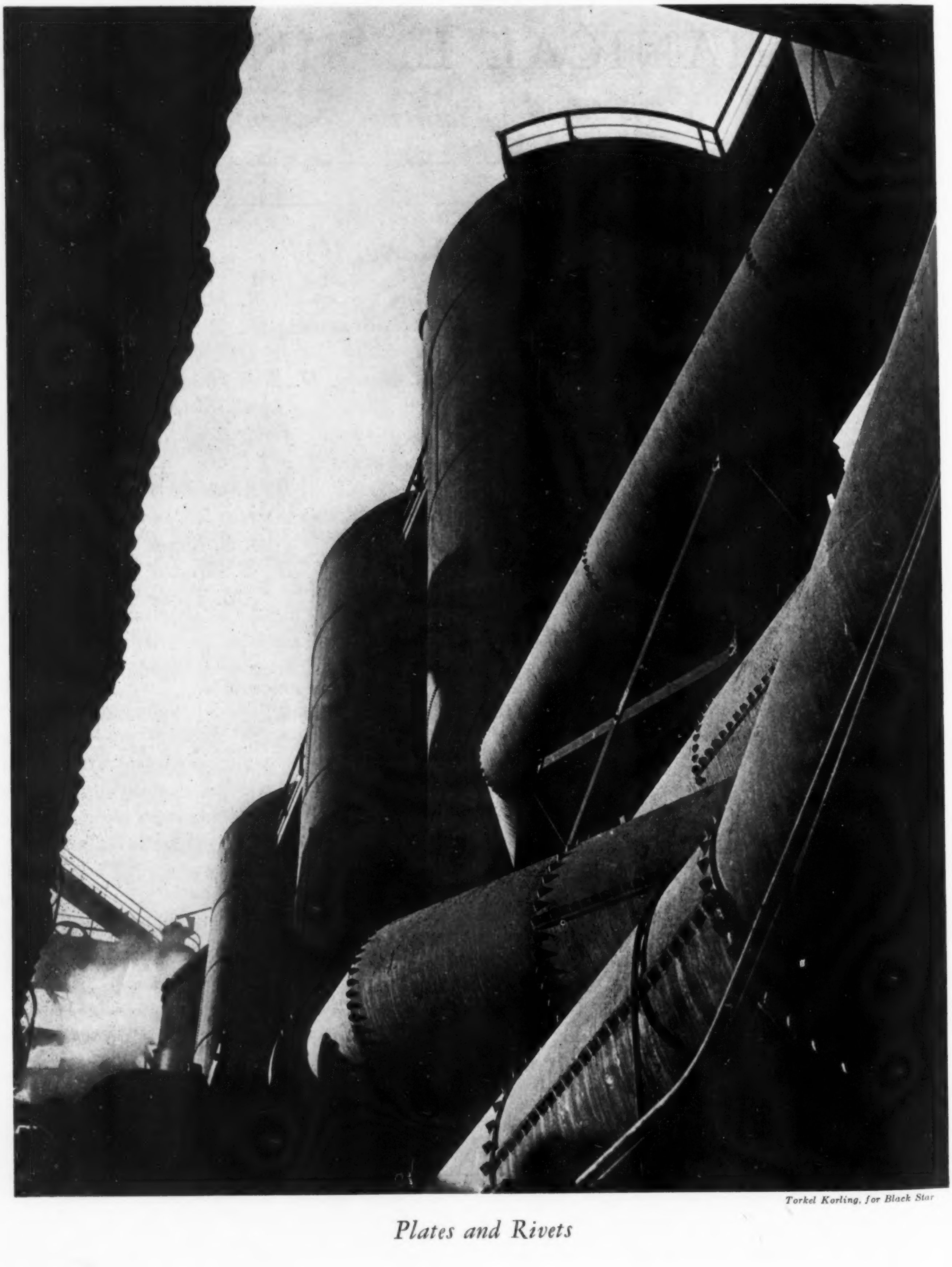

Torkel Korling, for Black Star

Plates and Rivets

VOLUME 60
No. 3

MECHANICAL ENGINEERING

MARCH
1938

GEORGE A. STETSON, *Editor*

Measuring Surface Quality

PROGRESS in machine-shop practice has been a race between precision and fine surface finish on one hand, and the accurate measurement of these characteristics on the other. One recalls the elation of Watt in discovering that Wilkinson's boring mill could machine an engine cylinder true to within the thickness of a shilling. No elaborate instruments were needed for such measurements. Adoption of the system of interchangeable-parts manufacture early in the nineteenth century, however, demanded greater accuracy in adhering to design dimensions than could be obtained by the hand-fitting of one part with another mating member in the same assembly. In the Connecticut arms shops, therefore, gages and the art of gaging were developed to meet the need for standards of measurement; and even the unit of measurement itself had to be precisely defined. Thus it has frequently happened that just about the time production methods reached the point where dimensions could be produced as accurately as they could be measured, new techniques in measurement would be developed, and the challenge was thrown out to machinists to reduce the limits of tolerance and increase the economic production of more perfect and accurately dimensioned surfaces.

Side by side with these improvements in machine production and management came designs of machines whose proper functioning depended on the possibility of securing precision with economy. The automobile with hand-scraped moving parts that had to be worn in by a thousand miles of careful driving gave way to the modern car, more cheaply produced, that can be safely operated without this precaution. Routine shop production today has attained a degree of precision found only in the toolrooms of yesterday. A striking example of what this means is to be found in plants producing airplane engines, and more recently in the announcement, noted on page 252 of this issue, of the mass production of low-powered Diesel engines.

So far have we progressed in this race between the ability to produce and the ability to measure high-quality surfaces that a number of new techniques in measurement have been devised. In the November issue of MECHANICAL ENGINEERING an extensive review of Schmaltz's classic in the German language on this subject provided engineers in this country with a survey of these techniques; and this month the writer of that review presents an extensive article on the profilometer, developed for laboratory and also for production use, by means of which it is possible to secure magnified records of surface irregularities of almost molecular dimensions. The layman reads with amazement that reliable rugged units have been built that make records of magnifications of the order of 50,000×, at which magnification "a microinch is nearly $^1/_{16}$ in. on the record and a human hair would be about 15 ft across. This magnification is necessary," the authors continue, "to record the surfaces being used in every-day production of automobiles and other machinery."

We appear to be just at the beginning of an exploration of the subject of surface finishes and of the development of techniques for laboratory and routine production use by means of which such finishes can be examined and rated. The paper referred to is one attempt to bring measurement abreast of production.

New Projects for A.E.C.

LAST month's report of the 1938 annual assembly of the American Engineering Council, pages 178 and 179, was, because of time and space limitations, inadequate as a complete account of the work of the staff and several important committees. Because of the organization of the Council its members are not persons but engineering societies and clubs whose elected or appointed representatives are the only ones who are in actual contact with the Council's work. On these representatives, therefore, rests the responsibility of carrying back to the societies they represent, and to the members and governing bodies of those societies, reports of the Council's activities and views of its needs.

Back of the Council are, perhaps, 60,000 engineers, members of the constituent bodies. If the Council's meetings, practically restricted now to the official representatives, attracted engineers to Washington in approximately the same ratio that individual members are attracted to conventions of the national societies, a gathering of from six to ten thousand persons would result. It is difficult to imagine what such a convention would be like, or what it might accomplish. It would be an impressive and probably an unwieldy body. But if one may judge by the experiences of representatives on the Council as now organized who attend the assembly for the first time, a great enthusiasm for the work of the Council would sweep the country.

Thus, perhaps, one of the problems of the Council

as it is organized lies in the fact that only an infinitesimal number of engineers have a personal first-hand knowledge of its activities. The great majority of engineers must rely upon news that comes to them through engineering-society publications and through second-hand reports made by their society representatives. Sensing this, the Council decided at its meeting in January to set publicity as a major study for the coming year.

Publicity about what? it will be asked. Here the Council faces a situation shared by all organizations and even by manufacturing plants. Routine tasks are not news; new products are. But the organization performing the routine tasks must be kept in the public eye, although the job is more difficult than telling about the latest marvel.

It is the new gadget that catches the eye and convinces the public that the world still moves. The task of the American Engineering Council in keeping alert the interest of engineers would be easier if it had new projects to announce. Fortunately, several were proposed at Washington in January. It would seem to be good business to make an early study of their value, and to embark upon them as soon as possible. News about them would enliven reports of routine tasks and be convincing evidence of a live and usefully employed organization.

Numbers in the Professions

REPORTING to the Board of Overseers of Harvard University, President James B. Conant wrote that "it seems evident that we are in danger of reaching the condition already so acute on the continent of Europe where the problem of unemployment in the learned professions demands attention even in countries racked by political and economic troubles." Further, he is reported to have made the statement that he would attempt to "substitute men of greater ability for those who stand in the bottom quarter of the class." The means is said to be a more rigorous rejection and a wider financing of able students.

If memory serves, it was President Hadley, of Yale, who said that many a good ditch digger had been ruined by a college "education," and although the statement probably did not grace an official report it had back of it much of the same concern over waste in education that President Conant expresses.

Although higher education and an opportunity to enter the professions and white-collar jobs have come to be regarded as the right of a growing number of young people in this country, there are many who echo President Hadley's statement and who are in agreement with President Conant's desire to see these opportunities made available on a basis of intellectual capacity and extended more widely to those whose only handicap is lack of funds. Efficiency is the principle involved, not a disbelief in the social value of more education. Coupled with this is the common-sense view that certain persons would be better off, and society itself better served, if young people were trained for careers to which they are best adapted rather than for those which fashion and unrealizable hopes urge them into.

It may be that the tide will turn as a result of the increasingly more favorable consideration being accorded workers in the trades and mass-production industries as compared to the disregard with which unorganized white-collar and professional workers of college training are treated. Indeed, it may happen that productive workers in industry will soon acquire such prestige and economic preferment that young people will attempt to enter through the shop, rather than the office, door.

Fortunately, for engineers, both doors give access to the highest rewards of professional life. Fortunately, too, for engineers, education in engineering schools has a high vocational value and fosters an adaptability that minimizes the chances of its being wasted, regardless of what career those who undergo it are forced to follow.

Newspaper accounts of President Conant's report fail to state how generally his fears for unemployment in the learned professions apply to engineering. Certainly, as yet, no such concern is expressed regarding engineering as is felt in law and medicine where restriction is frequently preached and practiced. Figures on registrations in engineering schools, quoted on page 256 of this issue, show a total of 84,547 for 1937–1938 as compared with 67,569 for 1936–1937, based, to be sure, on a slightly greater number of institutions reporting in the present year. In view of the increasing tempo of technological developments, this growth is not alarming as yet. What we need be concerned about is whether or not these eighty-four thousand are the young men who can make best use of the education they are receiving. This is a problem which the E.C.P.D. is tackling through its Committee on Student Selection and Guidance.

Lowering Production Costs

HAROLD G. MOULTON, president of the Brookings Institution, in several recent addresses, has been contributing measurably to clear and sane thinking on America's impasse with unemployment and restricted production. At the Indianapolis meeting of the American Association for the Advancement of Science, reported in our February issue, he set forth some of the fundamental factors involved in the impact of science on society. Elsewhere in this issue (page 247) excerpts will be found of an address delivered at the 1938 winter convention of the American Institute of Electrical Engineers, an address that was favorably received by the Metropolitan press. More recently, before the American Institute of Mining and Metallurgical Engineers, he is reported to have declared that "only by everlastingly improving technical processes and lowering the cost of production can we obtain progressively higher standards of living."

To mechanical engineers Dr. Moulton's utterances have the ring of obvious truth, for the principles he enunciates are axiomatic with them.

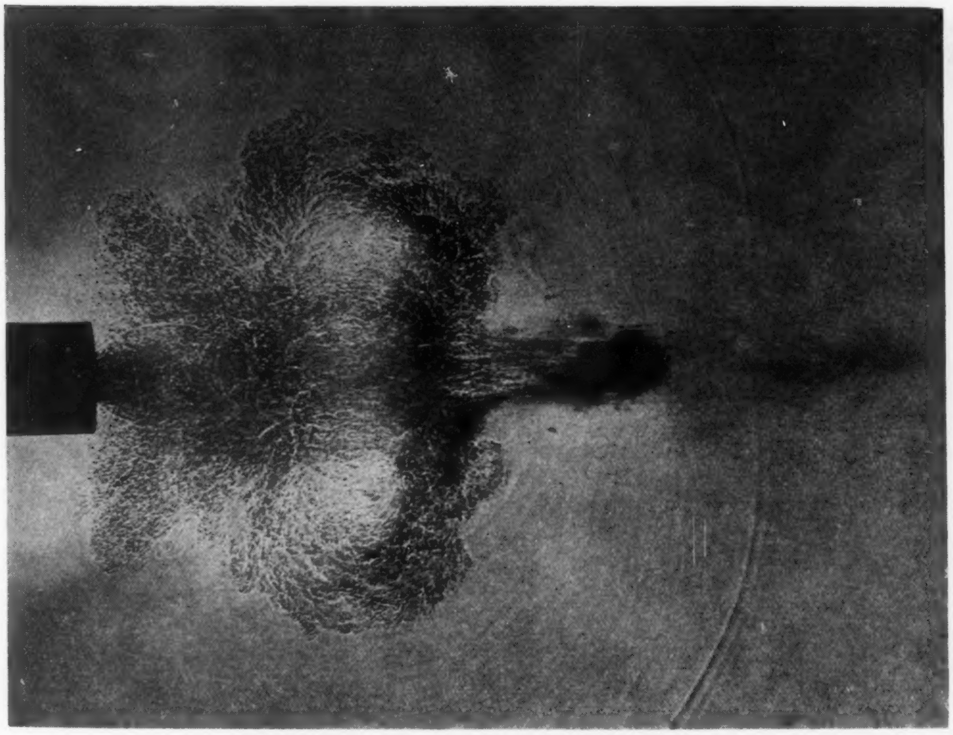

FIG. 1 AN EXAMPLE OF HIGH-SPEED PHOTOGRAPHY
(This photograph of a bullet, hot gases, and sound waves issuing from the muzzle of a 22-caliber rifle was made with an exposure of 0.00001 sec.)

SEEING THE UNSEEN

By R. MERWIN HORN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

HUMANS are gifted with five senses, all of which are important in their daily lives. One of these, sight, which is considered most important, has many limitations not ordinarily thought of. Some of these are the inability to see minute objects, and objects at a great distance.

Scientific investigation has favored us with many instruments to aid the eye in overcoming these deficiencies. The microscope is a familiar example of such instruments. It, as we know, is an instrument with which we can observe minute objects that are normally hidden from our sight because of their diminutive size.

Another marked deficiency in our sense of sight is its inability to see rapidly moving objects. This is the deficiency in which Prof. Harold E. Edgerton and his associates, K. J. Germeshausen and H. E. Grier of the electrical-engineering department of the Massachusetts Institute of Technology, have been interested. Over a period of years, they have developed an instrument, known as the stroboscope, which will aid the eye to see rapidly moving objects as though they were running slowly or even remaining motionless, when, in reality, they are moving under their actual working conditions.

Abstracted from the Ninth Robert Henry Thurston Lecture, delivered at the Annual Meeting, New York, N. Y., Dec. 6–10, 1937, of The American Society of Mechanical Engineers.

The stroboscope consists of an electrical circuit that is capable of storing high voltages in electrical condensers. These high voltages may be released in the form of a spark discharge either through air or a gaseous tube, such as mercury or argon. The resulting flash of light from this discharge is of extremely short duration, approximately 0.00001 sec. In this short interval, moving objects can have no perceptible motion. It is apparent, then, that, if we cause a discharge to occur in the proximity of a moving object, it will appear to be motionless.

If an ordinary camera is focused on the moving object and a discharge is created so as to illuminate the object we may obtain, what is commonly called, a "spark" or "stop-motion" photograph. A typical photograph, a bullet, hot gases, and sound waves issuing from the muzzle of a 22-caliber rifle, is reproduced as Fig. 1. By taxing our ingenuity, different types of contacting and control mechanism may be devised, making it possible to obtain photographs at any predetermined position in the action of a moving object.

Not only can a single discharge be created, but a series also may be produced in succession at regular frequencies, ranging from a few to several thousand per second. These may be synchronized with the moving object by a suitable contacting device to enable us to study the action of the object and determine whether any irregularities, such as vibrations, eccentrici-

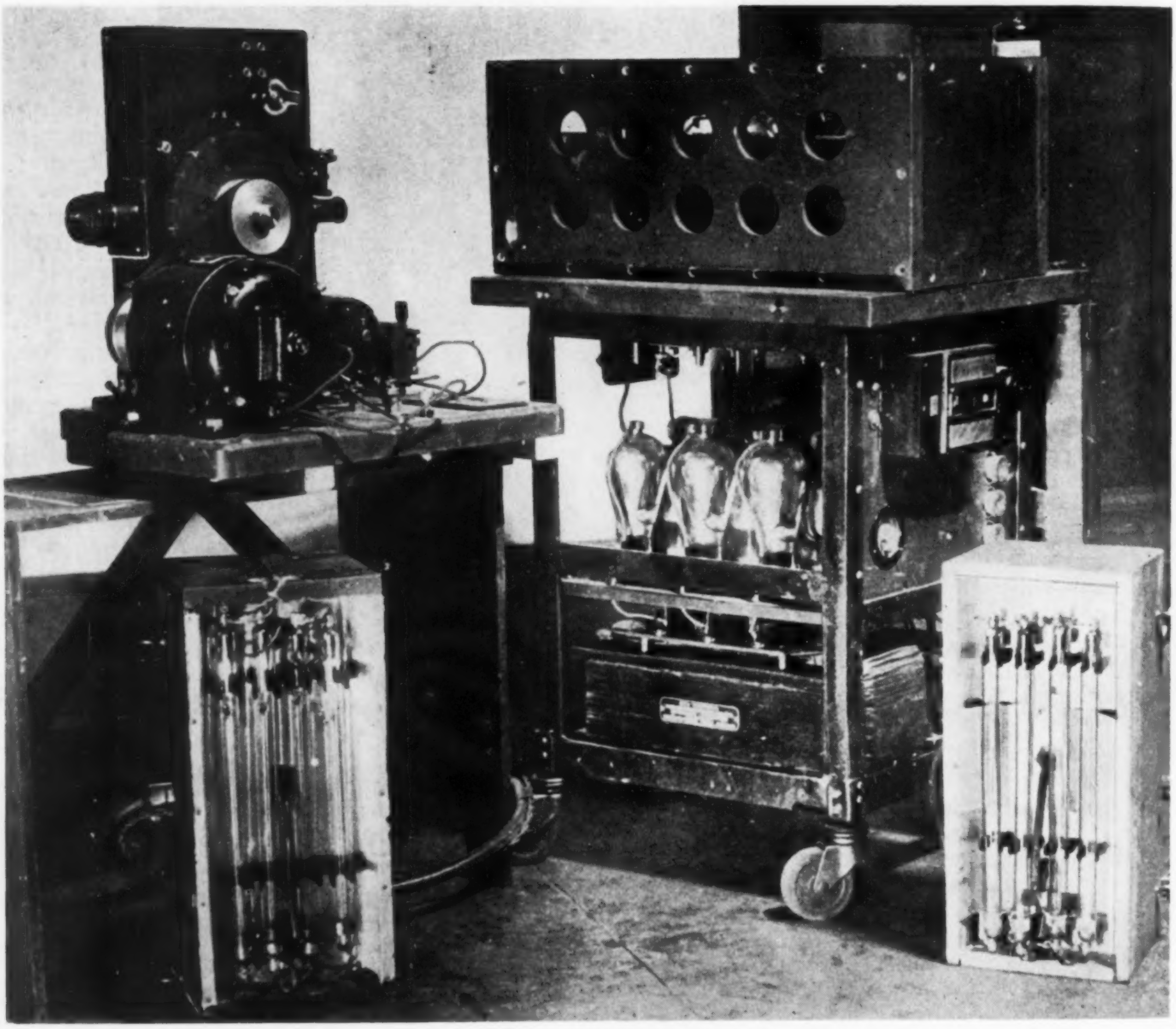

FIG. 2 HIGH-SPEED CAMERA AND ASSOCIATED EQUIPMENT

ties and the like, exist. We not only can watch these moving objects but, if our contacting device is of such a nature that we know the exact frequency of the flashing light, we may also measure speed accurately without connections to the moving object, providing this motion has a definite and constant frequency.

It is evident that the stroboscope in itself is not sufficient when we wish to learn something of the behavior of a moving object that has an irregular frequency or completes its motion in such a short time that we are unable to see what is taking place. Professor Edgerton has developed a unique high-speed camera (Fig. 2) to operate in conjunction with the stroboscope. Standard 35-mm film is used and moves through the camera at 75 fps when taking movies at the rate of 1200 frames per second. The path of the film through the camera is shown in Fig. 3. A commutator is placed on the main drive shaft of the camera (Fig. 4) and operates, through brushes, the control circuit of the stroboscope, causing one flash to occur for every commutator segment as it passes the brushes. The segments are accurately placed on the commutator so that the film moves the distance of one standard motion-picture frame for each flash of light. The camera has no shutter mechanism but depends solely on the intermittent light for shutter action as well as for subject illumination. In making high-speed motion pictures, the camera is operated at a speed that will give the most satisfactory results depending on the speed of the moving object. Camera speeds can be controlled so that a few hundred or as high as 6000 exposures can be obtained per second with such accuracy that precise measurements of acceleration, velocity, and the like can be made on the film.

Among the applications of the high-speed camera are, for example, precise measurements of bullet velocities in the study of ballistics, investigation of detrimental vibrations in high-speed machines of all types and also in automobile engines and chassis, study of airplane propellers and parts to determine frequency and amplitude of vibrations, and accurate measurement of time intervals to within a fractional part of 0.001 sec by the high-speed photography of a syncro clock graduated in thousandths of a second. Even medicine has found uses for this camera in studying the action of high-speed microorganisms. In fact, the applications of the high-speed camera are limited almost only by one's imagination.

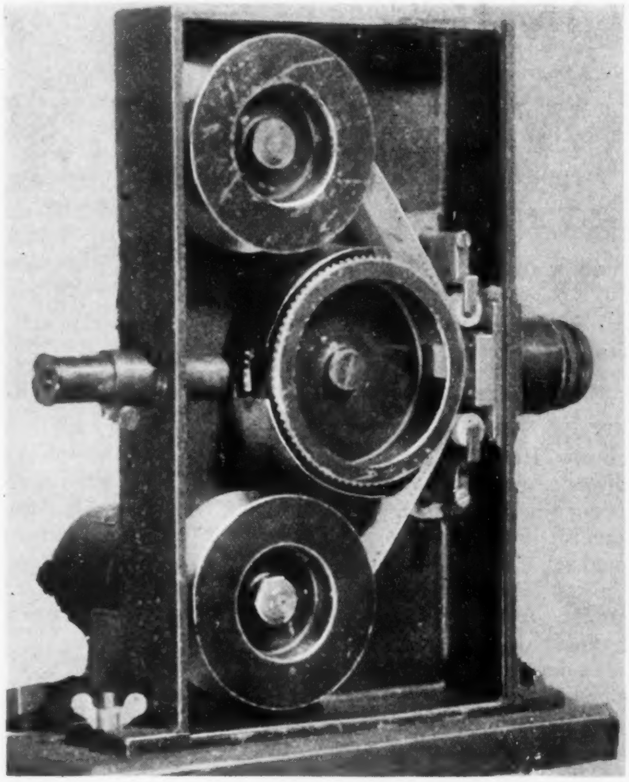

FIG. 3 HIGH-SPEED CAMERA WITH THE FRONT COVER REMOVED

(The upper film spool, main drive sprocket, lower take-up spool, and path of the film through the camera are shown. Objective lens can be seen projecting at the right and the focusing tube at the left.)

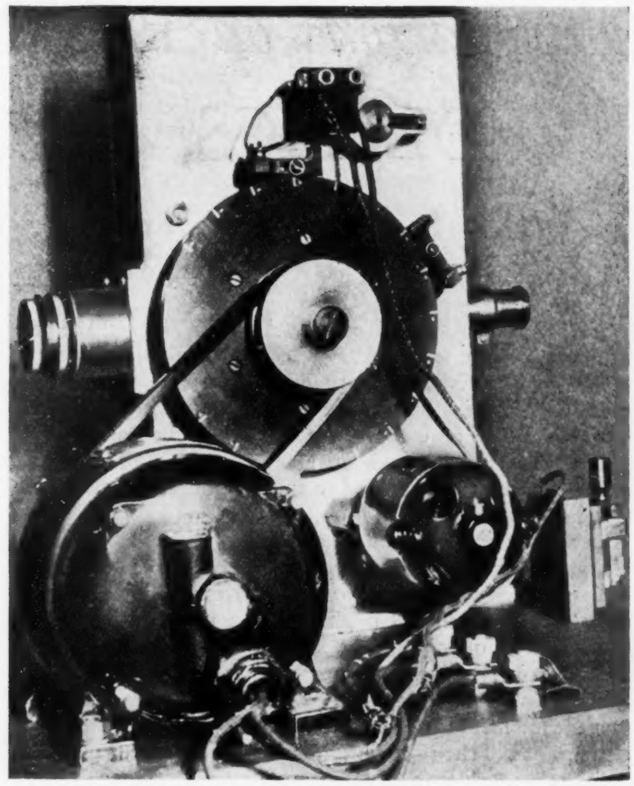

FIG. 4 REAR VIEW OF THE CAMERA

(The commutator on the main drive shaft operates control circuit through brushes and causes a flash as a commutator segment passes the brushes. Small motor at the lower right drives the take-up spindle.)

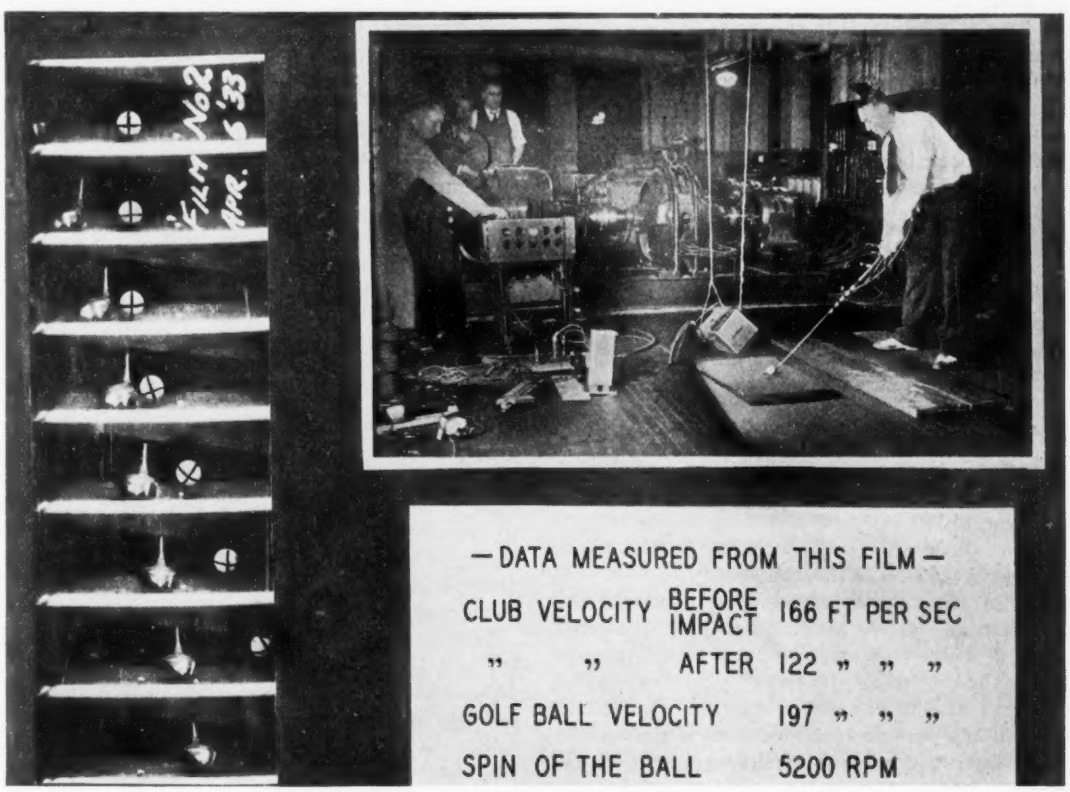

FIG. 5 TYPICAL LABORATORY SETUP

(Making high-speed motion pictures of a golf ball, section of film taken, and data obtained. Film speed 1000 pictures per sec.)

Observations on ECONOMICS, POLITICS, *and* GOVERNMENT

By JAMES D. MOONEY

GENERAL MOTORS CORPORATION, NEW YORK, N. Y.

WHEN YOUR president, Dr. Andrey A. Potter, and your executive secretary, Frederick M. Feiker, asked me to speak at your dinner tonight, I told them that I should not only be honored by the privilege but that I should actually enjoy it. I have spent practically all of my life arguing with other engineers, and I can imagine no greater pleasure than having the situation arranged so that, for once, I can do all of the talking myself.

Doctor Potter, Mr. Feiker, and I thought, after some discussion, that you might be interested in certain observations I might make on some of the forms of government in the countries abroad. Further, I might compare these with our own American form of government, as a means, possibly, of clarifying your own attitude toward this important problem of government we are all struggling with at the present time.

I made my first trip abroad with the American Expeditionary Forces as one of the two million men who went over to France to make the world safe for democracy. And in the last twenty years I have spent about half of my time abroad. It has been my good fortune to occupy a front seat at many political dramas in those twenty years; the turmoil in Germany, the throwing out of royalty in several European countries, many revolutions in Latin America, and the experiment in so-called communism in Russia. Besides, I have always had a financial stake in the outcome of the drama. And as you well know, such an interest has a way of sharpening one's powers of observation and of deepening one's insight into what is really going on.

Out of this experience, then, may I, tonight, simply make a report to you on my observations of governmental structures abroad. Perhaps, too, you will be patient with me while I offer a few suggestions as to how you and I can do our part in keeping our own American governmental house—the house which has sheltered us comfortably and even luxuriously for a hundred and fifty years—weather-stripped and insulated against the economic tempests and political hurricanes which beset us at the present time.

In this report and recommendation, I should like to leave with you but four ideas

(1) The terms fascism, communism, socialism, and democracy are of little value in comparing the forms of government throughout the world.

(2) Governments differ principally according to the extent to which they control the lives of their citizens.

(3) The trend of many governments today, and, the one which constitutes a danger for us in America, is the trend toward too high a degree of integration, too great a control over every area of the lives of men.

(4) Our most practicable defense in America against too much goverment in our private economic lives is the maintenance and preservation of our traditional two-party political system, the system that has divided us, at least at election time, into Democrats and Republicans.

LITTLE SIGNIFICANCE TO POLITICAL TERMS

While Walter Lippmann, Dorothy Thompson, General Johnson, Heywood Broun, and the other columnists whom the editors of our great newspapers have so kindly delegated to do all our thinking for us—while these brilliant columnists have been battling passionately about how many economic angels could stand on the point of some political needle, called communism, fascism, socialism, or democracy, I have been forced into the conclusion by experience that there is little significance to these terms at all.

My first great disillusionment about these political terms came during my experience when I was contributing my infinitely small bit toward making the world "safe for democracy." In that war, I discovered along with many of you that symbols didn't make much difference, that underneath their various uniforms men had pretty much the same hopes and fears, joys and sorrows, loves and hates, whether they fought for emperor or czar, king or potentate, dictator or democrat.

My second great disillusionment about these political terms came during a trip I made through Russia in 1931. I had the opportunity at that time to observe throughout Russia many vast industrial projects under construction—the great hydroelectric power plant at Dnieprostroy, the coal mines of the Donetz Basin, the huge tractor and agricultural implement plants at Kharkov, and the vast state farms in the Caucasus. I had understood meantime that I was going to observe an experiment in communism. But, all of the economic life in Russia, as I saw it with my own eyes, had the same general pattern I had observed throughout the rest of the world, including my own country. When I confronted various Russian officials with this observation, they explained to me that they hadn't yet had time to get around to communism; they were too busy with their Five-Year Plan!

UNIVERSAL PATTERN OF ECONOMIC LIFE

Indeed, it has been my general observation that not only in different countries but also from generation to generation men go on earning their living in much the same manner. Notable changes and improvements can be credited from time to time to the scientists and engineers, and in general to improved technology, but economic laws and the processes of production and distribution display a lively contempt throughout history for changes in the political complexion of government.

Farming, spinning cotton, weaving cloth, making shoes, building ships, manufacturing motorcars, operating railroads, department stores, and fruit, vegetable, meat, and fish markets, and trading posts display no more variation in their character in different countries than can be discovered within the boundaries of any one country. In other words, they show no variations whatsoever that can be ascribed to political boundaries. These processes of production and distribution vary only ac-

Address at the All Engineers' Dinner, sponsored by the American Engineering Council, Washington, D. C., Jan. 14, 1938.

cording to the degree to which methods have been improved through the use of tools and technology.

Meanwhile, and particularly since the middle of the nineteenth century, when the industrial revolution got into high gear and brought economic issues sharply to the fore in the western world, politicians have preempted or achieved authority under one economic plea or another to the masses. America has no monopoly on the "full dinner pail" we inherited from Mark Hanna, the "chicken in every pot" Herbert Hoover insisted we take even if we liked sirloin steak better, or the New Deal that promised us a whole table d'hote dinner but threatens from time to time to leave us grateful if we actually get the hot soup. These political symbols have been used continually for generations throughout the world, and they are being used universally right now. Symbols for better food, clothing, and shelter are always useful in inspiring either bloody or bloodless revolutions. History shows that empty bellies are the most powerful generators of political change.

I have observed generally in my travels that the pictures the politicians paint, which are bulging with full dinner pails for the workmen and with pots of gold for the business men, have strange or even weird economic colors. In fact, the programs that are projected for taking us all into the land of milk and honey are often openly in defiance of some old and universal economic laws.

CARDINAL PRINCIPLES OF ORGANIZATION

In appraising the many experiments in government throughout the world that have been tried during our generation, it is important that we should not be thrown off the track by the incident that various revolutionary movements or changes in government have adopted different symbols around which to rally their supporters. The important point is to recognize the plain fact that, once the controlling group gets into power, practical circumstances of the situation force the new leaders to organize the government according to organization principles that are as old as the hills.

All through the ages, human groups have been organizing themselves to move on various objectives. And in all of these organizations we find three cardinal principles governing their form and operation: (1) Coordination, with its implied corollaries, authority and leadership; (2) the scalar process, that is, the delegation of authorities and duties; (3) functionalism, or the division of duties according to the character of the work to be done.

Wherever we find sound group association or group movement progressing effectively toward an objective, we find the formal structure and the process of moving in full harmony with these principles, whether the organization happens to be concerned with government, industrial problems, military objectives, or any other activity in which a group of men work together to get a job done. Further, it is plain that all effective or efficient governments have functioned according to these principles, wherever the leaders have had the wisdom and the strength to apply them. Still further, we must recognize that the general objectives of government are the same in every country.

OBJECTIVES OF GOVERNMENT AND THE IDEAL ECONOMIC STATE

The primary objectives of government are first, military and second, economic in character. National defense, because of disturbed political conditions throughout the world, is today the first consideration; an improved economic order is the second. After national security, people everywhere want more and a greater variety of things to eat. They want more clothes and more shoes. They want more comfortable places in which to live. All governments are seriously concerned with policies which will provide group movement toward these ends.

In the ideal economic state, steps would be taken to see that no economic group, in pressing for its own advantage, did anything inimical to the general economic progress of any group or of the nation as a whole. Every economic group would be challenged to play the game fairly with the others. In this ideal economic state, the consumer's interests would be placed above all else. A consciousness would be maintained of the fact that only a vigorous production or transformation of raw materials into consumer goods and the efficient distribution of these goods can create a high standard of living. It would be realized that what is inimical to the interests of the consumer is ultimately inimical to the interests of industry. Profiteering, charging more for the goods or services than they are worth would be discouraged. Racketeering, the levying of tolls on industry for no service at all, would be banned.

In the ideal economic state, the government would stick to its natural functions of maintaining order and security at home and providing a defense against external enemies. By limiting the extension of its functions, and by performing its own normal functions with thrift, it would avoid laying on productive industries the heavy hand of taxation that has been the cause of the traditional clash between government and industry in all history. Unfortunately, we observe today, in all of the great industrial countries, taxes that are starving or crushing or drying up industry; the thread of this color is weaving itself with tragic irony into all of the relations of industry and government.

THE GREAT DIFFERENCE—THE DEGREE OF INTEGRATION

Now I have not come here to tell you that all governments throughout the world are alike. Not at all. But I do want to tell you that the general structural pattern, the organization principles under which they operate, and the general objectives they seek to attain are universally similar, regardless of what the form is called. And I want to tell you, most importantly, that the principal difference I have observed in my twenty years of watching and feeling the various governments in many countries actually functioning—the principal difference between these governments, lies in the degree to which they are integrated.

By "the degree to which they are integrated" I mean the extent to which control is centered in the government over the many areas of individual, community, and national life. It has become the fashion for every newly established régime or government to promulgate the thesis that it is projecting new principles into its operation, among which the principle of high integration is usually prominently displayed. Actually, a characteristic which appears in almost all ancient forms of government is the unlimited range of governmental authority and control. How ironic, therefore, that many modern countries which are generally regarded as conducting experiments in government should actually be operating according to the methods of the governments of antiquity!

Probably you gentlemen who have traveled or worked professionally abroad have observed that the degree of integration depends upon the amount of external military or internal economic pressure that is being imposed upon the nation at the time. Military or economic crises set the stage for moving a country in the direction of extremely high integration. In your studies of history, you have probably observed that throughout the classical revolutions the most important net result was that the degree of integration was changed. The general process that seems to take place in any one country really represents, from time to time, only a change in the degree

of integration of the government, in response to real or simulated emergencies.

Most of the principal countries throughout the world have been moving, in the last twenty years, in the direction of high integration. Governments everywhere seem to be taking an increasing interest in and control over the economic life of their respective citizens. Picking examples out of the bag, I might mention Germany, Russia, Italy, England, and the United States as examples of countries that have had strong enough governments in the last several years to impose, in varying degrees, remarkable and increasing governmental control over industry, agriculture, and the general economic life of their citizens.

THE AMERICAN TWO-PARTY SYSTEM

Now, you and I want strength in our government, but I know you will agree with me at the same time that we are eager to retain the greatest possible degree of individual freedom. I am convinced, meantime, that the defense we need in the United States against too much governmental control is to be found in the traditional American two-party system. Our political scheme, our two parties, the Democrats and the Republicans, have given us, at least in your lifetime and mine, a reasonably good compromise between a strong government and individual freedom.

I should hate to say that they could not have done a lot better. As a matter of fact, I have spent a lot of time and energy in my life, just like any other American, grousing about the government. But I must remind you that men are not angels and that governments are controlled and operated by men, by politicians. I came to the conclusion a long time ago that it is just as difficult to be a great statesman as it is to be a great financier or a great engineer. My hat is off to the politician who makes a reasonably good average record in the compromise between so-called "sound principles" on the one hand, and, on the other, what people in their inertia will accept at the moment.

To be practical, therefore, we must compare our political and governmental scheme not with some imagined ideal but with actual governmental schemes in other countries. Governments abroad seem to go to one extreme or the other. Either the government is so highly integrated, so strong, so "full of itself" that the individual loses too great a measure of his individual freedom; or the government, on the other hand, is so weak that it cannot discharge effectively its ordinary functions.

For a hundred and fifty years, our American two-party system has given us a good practicable compromise in government. We have had strong government, but we have escaped extreme tyranny.

TOO DEMOCRATIC—A SIGN OF WEAKNESS

I have emphasized the two-party system rather than identify our American scheme simply as democratic, because there is such a thing possible as a country being too democratic. We shall be unhappy here if we move into a political situation in which we have several political parties pushing us all around and striving for control. The trouble with having too many parties in the scheme of things is that no one party has enough power to organize a sufficiently strong government when it is elected to office.

We have observed an excellent example of this in France in the last 12 years. You are all familiar with political conditions there, and you know that they have gone from one crisis to another, arising out of their rather disintegrated political situation. France has undergone the formation of several parties, the continual throwing out of one crowd after another, and, generally, a rather chaotic condition. Likewise, one of the outstanding characteristics of Germany during its weak and transient régime as a republic was the multiplicity of parties, which kept breaking up and multiplying until the final debacle. An "overdose" of democracy made the patient ill, and Doctor Hitler was called in. When this sort of thing happens in a democracy, it provides gratifying material for the "integrationists" because they like to point to such a collapse as an example of the breakdown of democracy.

THE MIDDLE ROAD—OUR TWO-PARTY SYSTEM

A system like our own, with its two major parties, avoids this disintegrating tendency and gives ample assurance that either party, if elected to office, will be able to carry out effectively the functions of government. On the other hand, the danger inherent in one dominating party unchecked by sound opposition is obvious. The controlling party can swing to wide extremes of national policy without any check or counterbalancing force to bring the pendulum back to center. With the two-party system, however, the party of opposition is always able to act as a check, a strong and effective balance, against any form of extremism in government. The two-party system, therefore, is in itself our soundest defense against excessive governmental control inherent in a single, overdominate party. In the other direction, it is again our soundest defense against the weakness and disintegration that arise out of having too many political parties.

By now, however, you are probably saying to yourselves, "Well, what has all this got to do with me? What can I do about it?" And in coming now to my conclusion I should like to make a suggestion to you for the answer to this question. And the suggestion is this: I think you and I ought to be either good Democrats or good Republicans. If we have ideas and opinions on political economy, if we have ideas on how to organize and run the country, if we have ideals for an American government that would be strong and just and fair, we ought to work within the framework of the party that seems, according to our individual lights, to be moving most surely in the direction of those ideals.

HOW MUCH INTEGRATION? HOW MUCH GOVERNMENT CONTROL?

It seems obvious that, from time to time, we shall have external military and perhaps even further internal economic crises which will provide the emotional background for certain kinds of control that will be imposed upon us by a strong government. I am not saying that I like the prospect of this; I am simply trying to be realistic about the situation and to anticipate what will actually happen.

I believe that the choice which we shall have to make in our political scheme in the impending years is between a highly integrated scheme of government and a more moderately integrated one. In times of war or in other times of really intense national crises, I think we can all agree that we are willing to submit to a high degree of integration. But, in peace and ordinary times, we want only a moderate degree of integration in our governmental organization.

Accordingly, my suggestion to you engineers, who may be worried at present about these political and economic problems, is that you identify yourselves actively with one party or the other, as dictated by your own interests and convictions. As intelligent, thinking citizens, lend your full support to that party and, in turn, expect from that party some reasonable consideration of your point of view for governmental policy. Certainly, the most practicable thing we can do is to become

(*Continued on page 234*)

THE PROFILOMETER

A New Instrument for the Rapid Measurement of Surfaces

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WORKING surfaces of antifriction bearings require great accuracy and smoothness. Surface irregularities less than 10 microinches (0.000010 in.) in height produce effects that cause rejection of the bearing for many applications. In their continued program of bearing improvement, the manufacturers of SKF bearings reached the point where production had outstripped means of measurement. In other words, manufacturing had reached that point of perfection where no means were available for measuring dimensions of surface irregularities.

On the other hand, SKF Industries believed that still further improvement in surfaces would be justified by improved operation in the field, particularly in high-speed applications. Accordingly, development work was continued. Experience proved that, to achieve desired improvements, a practical method for measuring the surface irregularities was necessary so that the effect of changes in methods could be determined. The primary work of the organization with which the authors are connected consists in solving unusual technical problems that do not respond to ordinary methods of treatment. After looking into the problem, we undertook to (*a*) build equipment for measuring these irregularities, (*b*) use this equipment to determine how to reduce certain defects, and (*c*) develop methods and means for making necessary measurements in the factory.

The second item of the job is essential in this type of work. It is practically impossible to develop new and special measuring means as a cold laboratory project and then to turn them over to production. Instead, one must select problems to which the answer is of practical importance and then work on their solution with the idea of bringing new instrumentation and techniques to bear. In this way, methods and means are developed on the job, and time and the appropriation are spent on that which counts. When this procedure is followed, transfer of the results from the laboratory to the shop is comparatively easy. Often, results obtained during the development are worth even more than the instruments developed.

PROFILOMETER FOR MEASURING SURFACE IRREGULARITIES

This work has been in progress for two years, and the results obtained form an interesting story which may be released by SKF Industries at a later date. The present paper deals only with the measuring equipment that has already found use in (*c*) industry, and appears to offer many practical applications.

Careful consideration of various instruments which have been used for measuring surfaces showed that none was suitable to our needs. Accordingly, an instrument was developed which represents decidedly new accomplishments in speed, sensitivity, range, accuracy, flexibility, and adaptability to practical problems. This instrument is called the profilometer, and employs the "tracer method."

The tracer method involves two parts: (*a*) a sharp tracer point that is moved over the specimen and (*b*) means for measuring displacements of this point. In this way, size and shape of surface irregularities can be measured. Since the irregularities are minute, the measuring system must include means for obtaining high magnification. In our instrument, the tracer is a diamond, and the measuring means electrical. The necessary amplification is obtained with a vacuum-tube amplifier.

For a decade, the tracer method has been recognized as about the only practical one for measuring the dimensions of irregularities of smooth surfaces. Numerous methods for measuring these irregularities are described in "Technische Oberflächenkunde," by Gustav Schmaltz, which was published in 1936. A summary of the contents of this book appeared in a recent issue of MECHANICAL ENGINEERING.[1] In 1929, Schmaltz described a tracer instrument using a tilting mirror and a long light arm to obtain the necessary magnification.[2] This method has been used subsequently by various workers.[3] Use of electrical measurement with the aid of a vacuum-tube amplifier was described by R. E. W. Harrison in 1931.[4] Thus, the present approach to the problem is not new in its fundamentals but presents a definite advance because of simplicity of operation and completeness of information not obtained with earlier apparatus.

Fig. 1 shows the elements of our profilometer. The tracer point consists of a sharp diamond that is held in contact with the specimen by delicate spring tension. The springs are arranged so that the point is free to move in a direction perpendicular to the surface but is restrained against other movements. Mounted integral with the tracer support is a tiny coil that is located in the field of a permanent magnet. Movements of the tracer are thus translated into electrical voltages in the coil which are proportional to the velocity of movement. These voltages are amplified and caused to produce displacements of the spot of a cathode-ray oscillograph. By proper design of the amplifier, these displacements can be made proportional to the displacements of the tracer point. This arrangement provides "vertical" magnification, that is, magnification for measuring the height of the surface irregularities in a direction perpendicular to the nominal surface. Magnification can be set to any desired value by adjusting the gain of the amplifier.

To obtain a pictorial record of a surface profile, it is necessary

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[1] "Surface Quality," a review of "Technische Oberflächenkunde" prepared by E. J. Abbott and Edgar Goldschmidt, MECHANICAL ENGINEERING, November, 1937, pp. 813–825.

[2] "Über Glätte und Ebenheit als physikalisches und physiologisches Problem," by Gustav Schmaltz, *Zeitschrift des Vereines deutscher Ingenieure*, Oct. 12, 1929, pp. 1461–1467.

[3] "Untersuchung verschiedener Methoden zur Bestimmung der Unebenheiten (Rauhigkeiten) von Metallflächen," by W. Kiesewetter, doctor's thesis, Dresden, 1931; also "Test for Smoothness of Machined Surfaces," by F. A. Firestone, F. M. Durbin, and E. J. Abbott, *Metal Progress*, April, 1932, pp. 57–59; and "Recent Developments in the Measurement and Control of Surface Roughness," by Harry Shaw, *Journal of the Institution of Production Engineers*, August, 1936, pp. 369–391.

[4] "A Survey of Surface Quality Standards and Tolerance Costs Based on 1929–1930 Precision-Grinding Practice," by R. E. W. Harrison, Trans. A.S.M.E., vol. 53, 1931, paper MSP-53-12, p. 115.

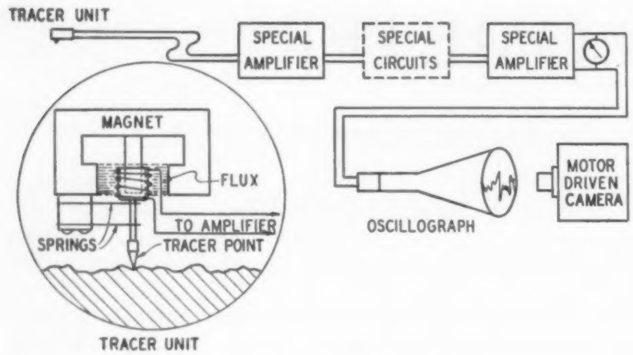

FIG. 1 DETAIL OF PROFILOMETER

to draw a two-dimensional picture, that is, "horizontal" magnification in a direction parallel to the nominal surface must be provided as well. This is obtained by photographing the displacements of the oscillograph spot on a film moving at right angles to them. By adjusting the ratio of film speed to tracer speed, horizontal magnification can be set for any desired value. This adjustment is obviously independent of the vertical magnification. As will be shown presently, this is of great practical value. For visual observation, a suitable oscillograph "sweep" can be used instead of the moving film.

Fig. 1 also shows a meter that is used to measure the voltage applied to the oscillograph and a portion marked "Special Circuits." The function of these elements will be discussed presently.

MEASUREMENTS ON TYPICAL SURFACES

Before discussing factors affecting the design of the profilometer and the advantages and limitations of the instrument, let us consider some typical surfaces and the characteristics of these surfaces that must be measured on practical jobs. Fig. 2 shows types of irregularities encountered on cylindrical work. If the surface is accurately round, free from roughness, and accurately centered, the resulting profilometer record is a straight line as indicated. If the surface is accurately round, and free from roughness but mounted eccentrically, the record is a simple wave as shown.

Departures from a true circle, such as are shown in the third sketch, produce long waves in the record. Most cylindrical work shows irregular waves of the general form illustrated in the fourth sketch. In addition to this, most surfaces exhibit finely spaced roughness that is superimposed on the waviness and is responsible for the "finish" of the piece. In general, the longer waves cannot be seen by either eye or microscopic examination. They may, however, play a controlling part in the operation of the piece. It must be appreciated that the radial scale in Fig. 2 is greatly exaggerated. In practice, the waviness is so shallow that the surface is still convex at the bottom of the deepest waves.

Fig. 3 shows profile records taken on an actual surface. The longer record was taken completely around the piece, while the shorter record was taken over about 0.020 in. of the specimen. Various waves and roughness indicated in Fig. 2 are clearly shown. For reasons that will be discussed presently, waves longer than one fourth of the circumference do not appear on this record.

A comparison of the horizontal and vertical scales of Fig. 3 shows that the profiles are not in true proportion. On the shorter record the vertical magnification is 50,000×, while the horizontal is 100×. This means that all irregularities appear 500 times as sharp on the record as they are on the piece. If the record were stretched horizontally to 500 times its present length, the surface would appear in true proportion and the irregularities would seem dull.

Two types of irregularity appear on this graph, and typical dimensions are given in Table 1.

TABLE 1 TYPICAL DIMENSIONS OF IRREGULARITIES ON SMOOTH SURFACES

	Microinches Width	Microinches Height	In. Width	In. Height
Fine roughness	200–400	1–5	0.0002–0.0004	0.000001–0.000005
Coarse roughness	1000–2500	3–7	0.0010–0.0025	0.000003–0.000007

From this, the fine roughness is seen to be composed of irregularities whose width is from 40 to 400 times the height. For the coarse roughness, the width is from 150 to 800 times the height. If either of these irregularities were drawn to scale, the profile curves would appear as practically straight lines. On the other hand, the sides of these irregularities slope in such a way that light is scattered from them, and visual observation of the piece with the naked eye shows a definite "finish."

From this, it is apparent that the widths of typical surface irregularities are many times their height, and, hence, common practice is to overestimate such heights by a factor of 10 to 100. We are used to viewing surfaces in plan view, either by eye or by microscope, and accordingly we have distorted ideas of the character of typical surface irregularities. By actual measurement, the true facts can be obtained, and results that appear mysterious from the "saw-tooth" conception of surfaces become obvious when the true dimensions are considered. It is entirely possible to have sharp tears and cracks in surfaces,

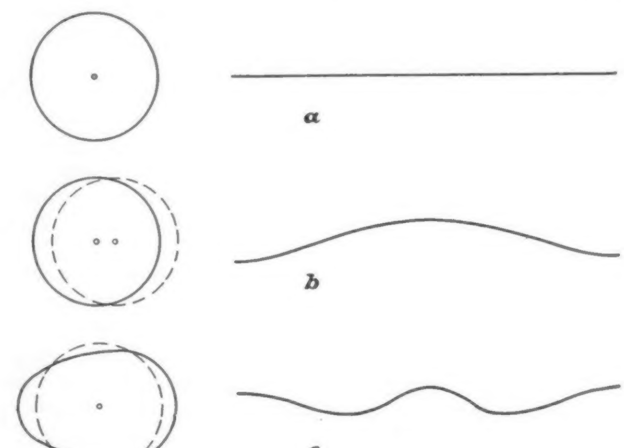

FIG. 2 IRREGULARITIES ON CYLINDRICAL WORK

(*a*, Round, smooth, centered; *b*, round, smooth, eccentric; *c*, egg-shaped, smooth; *d*, typical waviness; *e*, waviness and roughness.)

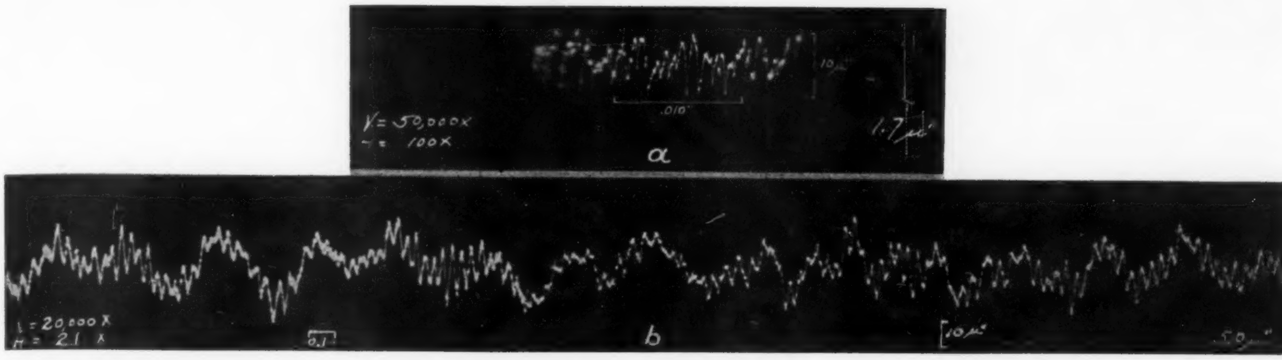

FIG. 3 PROFILE RECORDS ON GROUND CYLINDRICAL PIECE

(*a*, Roughness over small section; *b*, waviness around circumference. The symbol μ'' is used for microinches or 0.000001 in.)

but the typical irregularities of all surfaces produced with machining operations and abrasives are dull.

The longer record of Fig. 3 shows much longer irregularities on the piece than the roughness just mentioned and two types of waviness of approximately the dimensions given in Table 2.

TABLE 2 APPROXIMATE DIMENSIONS OF SURFACE WAVINESS

	Microinches		In.	
	Width	Height	Width	Height
Short waves	30,000 – 70,000	5–25	0.030–0.070	0.000005–0.000025
Long waves	200,000–500,000	10–25	0.2 – 0.5	0.000010–0.000025

The widths of these waves range from 1000 to 50,000 times the height. Evidence has been obtained that these waves may cause the rejection of the part in application.

In dealing with objects of these proportions, profile records in true proportion obviously would be useless in practical work. This fact greatly limits the practical value of microscopic observation and photomicrography. Another limitation of equal seriousness is that no optical instrument can form images of an object smaller than the wave length of the light used. For ordinary light, this is approximately 20 microinches (0.000020 in.). As was previously mentioned, many common surfaces have irregularities that do not exceed 10 microinches in total height and, hence, these heights cannot be observed by optical means. The widths, however, are much larger than the heights and can be observed by optical means. Hence, a microscope with suitable illumination is valuable for obtaining data on the plan view of surfaces but of little or no value in determining the height of irregularities on smooth surfaces. For most applications, heights of surface irregularities are more important than plan dimensions. For microscopic observation of surfaces, oblique or tangential illumination is usually more useful than ordinary "vertical" illumination.

Figs. 4 and 5 show other profile records taken on typical surfaces. These illustrate the fact that the characters of surface profiles vary widely but are similar in one respect; the principal irregularities are dull.

REQUIREMENTS FOR SURFACE-MEASURING EQUIPMENT

On the basis of data like those already given, one can arrive at a list of requirements for practical surface-measuring equipment. The list includes:

(1) Tracer point must be sharp enough to "bottom" the principal irregularities of the surfaces being measured.

(2) Load on the tracer point must be small enough so that neither the point nor the specimen is damaged.

(3) Sufficient sensitivity must be provided for measuring heights of irregularities as small as a few microinches.

(4) Sufficient range must be provided for surfaces of varying degrees of roughness.

(5) Vertical and horizontal magnification must be adjustable independently and over wide limits.

(6) Calibration must be made in terms of definite units, such as the inch.

(7) Means must be provided for tracing a wide variety of surfaces, without the necessity of removing small specimens from the piece.

The profilometer meets all of these requirements.

Tracer Point. If the tracer is to penetrate to the bottom of irregularities of a surface, it must have a tip radius smaller than the minimum radius of curvature of the valleys of the surface, which depends upon the width and height of the valley. These irregularities are wide shallow curves, which are many times as wide as they are deep. In appearance, they resemble rather irregular sine curves, and, for numerical evaluation, it is convenient to consider a corresponding sine curve (see Fig. 6). The radius of curvature at the valley of a sine curve is given by the formula

$$r = L^2/(2\pi^2 H)$$

where

r = radius of curvature at bottom of valley, in.
L = peak-to-peak wave length, in.
H = peak-to-valley height, in.

Substitution in this formula gives the maximum height of surface irregularity of various wave lengths which can be fully bottomed by a tracer point of given size. Typical data are presented in Table 3.

TABLE 3 MAXIMUM HEIGHT OF SURFACE IRREGULARITY OF GIVEN WAVE LENGTH WHICH CAN BE FULLY BOTTOMED BY TRACER POINT OF GIVEN RADIUS

	r_{max}, in.		
L, in.	0.001	0.0001 H, microinch	0.00005
0.005	1270	12700	25300
0.001	51	507	1010
0.0005	13	127	253
0.0001	0.5	5	10

From this, it is seen that a tracer having a radius of 0.001 in. can fully bottom irregularities as great as 1000 microinches, provided that the width of scratches is not less than 0.005 in. Such a point would be suitable for most ordinary machining operations. For smoother surfaces, this tracer could measure irregularities up to 50 microinches in height if they are as much as 0.001 in. wide. For finer scratches of the order of 0.0005

in. width or less, sharper tracers are needed. Fortunately, surfaces with finer scratches are usually smoother so that scratches which are as little as 0.0005 in. (500 microinches) wide are seldom more than 20 microinches high. Deeper irregularities of the order of 200 to 300 microinches in height are almost invariably several thousandths of an inch in width. For laboratory work, we have used a tracer having tip radius of 0.00005 in. (50 microinches). This appears to be amply sharp to bottom the principal irregularities of any metal surface that we have investigated.

Load on Tracer Point. If a tracer point of 50-microinches radius is not to scratch a surface, it must be held in contact with that surface with an extremely small load. Assuming that the actual contact area approximates a circle having a diameter of approximately 0.000020 in. (20 microinches), the contact area is then about 3×10^{-10} or 0.000,000,0003 sq in. If a load of 1 oz is applied to this area, the unit pressure is approximately 200,000,000 lb per sq in. This far exceeds the yield points of the material and the diamond and will scratch the surface or break the diamond, or both. This problem has been success-

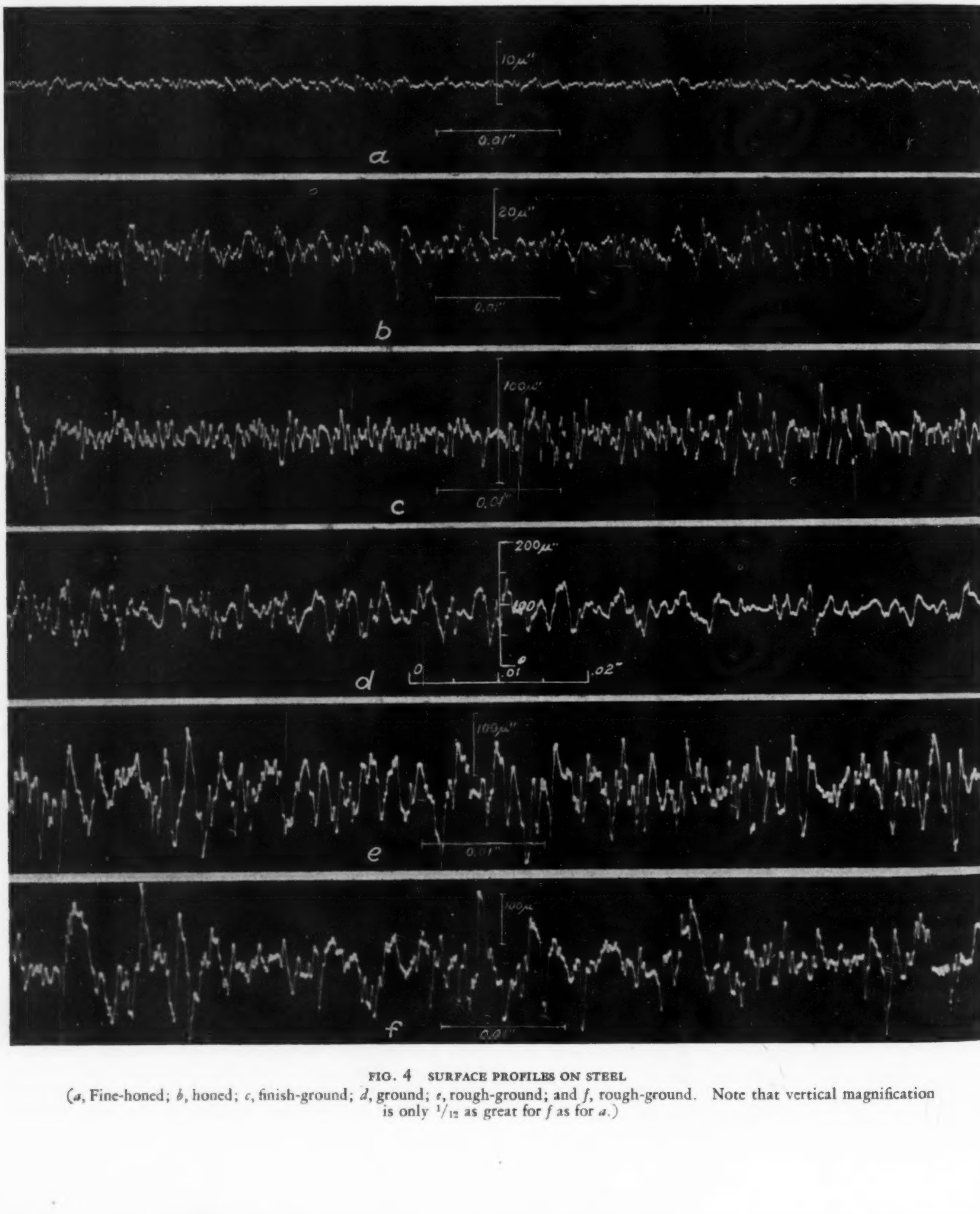

FIG. 4 SURFACE PROFILES ON STEEL

(*a*, Fine-honed; *b*, honed; *c*, finish-ground; *d*, ground; *e*, rough-ground; and *f*, rough-ground. Note that vertical magnification is only $^1/_{12}$ as great for *f* as for *a*.)

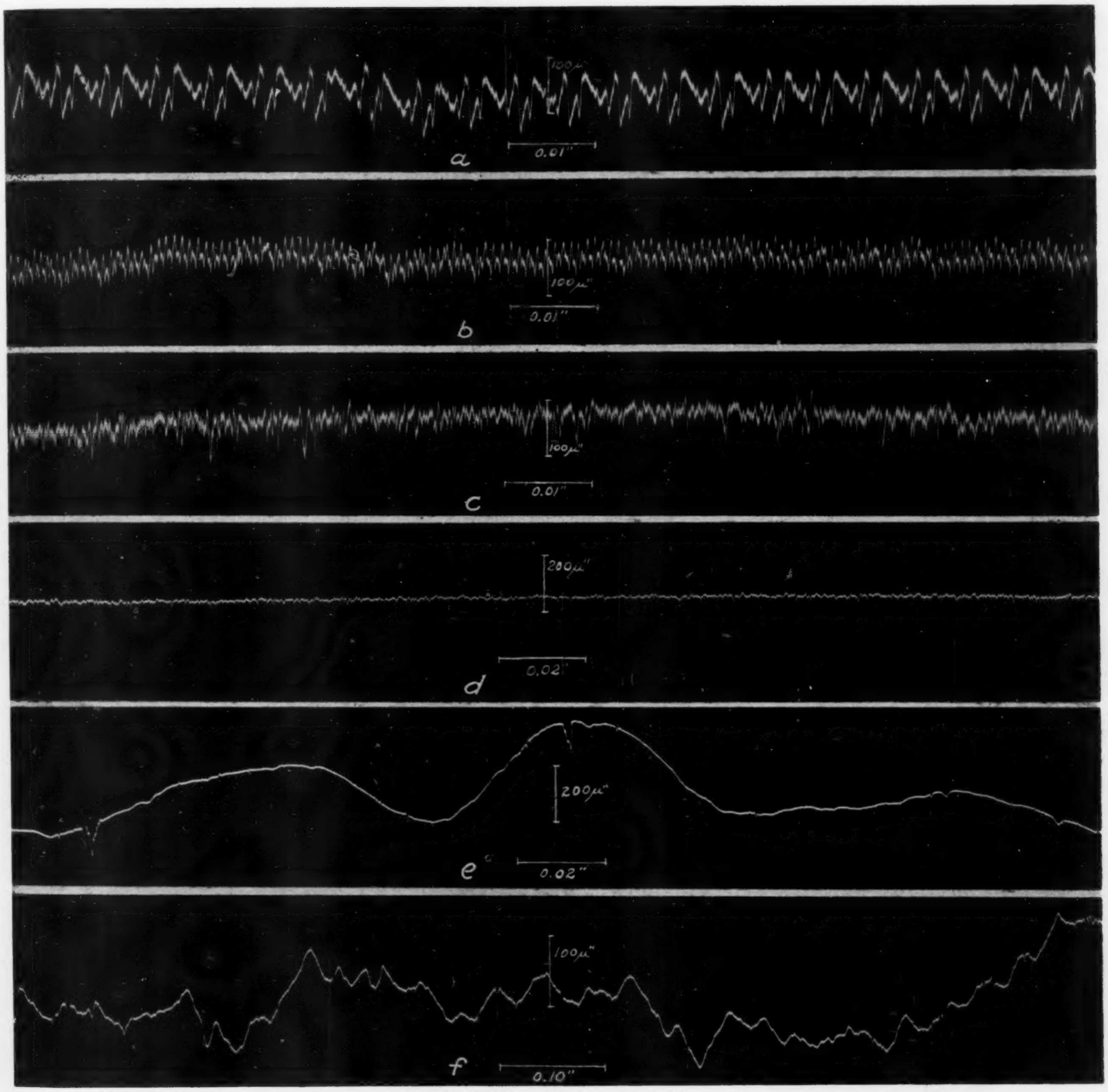

FIG. 5 EXAMPLES OF VARIOUS PROFILES

(*a*, Aluminum—diamond bored; *b*, bronze—diamond bored; *c*, bronze—rough-honed; *d*, glass—polished; *e*, porcelain—glazed; *f*, lacquered surface.)

fully met by reducing the load on the diamond to the point where unit pressures are low enough so that neither the surface nor the diamond is damaged. Obviously, this requires loads of considerably less than 0.001 oz, and this precludes the possibility of obtaining magnification with dial gages that require several ounces of tension for their operation. With the suspension shown in Fig. 1, it is feasible to use a diamond sharp enough to bottom the irregularities of the finest metal surfaces and to hold it against the surface so that it does not damage either the point or the surface. No sign of the passage of the tracer can be detected on the specimens, and the tracer points show no detectible wear after thousands of traces.

Sensitivity. The gain of the amplifier determines sensitivity of the profilometer, and rugged, reliable units have been built which allow magnifications of 1000× to 50,000× with equal facility. The practical limit for microscopic work is from 1000× to 2000×. At 50,000×, a microinch is nearly $^1/_{16}$ in. on the record, and a human hair would be about 15 ft across. This magnification is necessary to record the surfaces being used in everyday production of automobiles and other machinery.

Range. Low magnification is much easier to obtain than high magnification, so that extending the range to rougher surfaces is no problem. For rough-machining operations, irregularities are seldom more than 0.001 to 0.002 in. (1000 to 2000 microinches) in height, and these can be measured with the

same equipment by simply turning the gain control on the amplifier. Still rougher surfaces can be measured with a tracer of modified design.

Control of Horizontal and Vertical Magnification. As previously indicated, horizontal magnification for any job should be selected to cover an appropriate length of specimen at a scale that will show the irregularities it is desired to measure. For finest roughness, it is convenient to use a horizontal magnification of about 100× to show the individual irregularities. For waviness measurements, it is necessary to use much smaller horizontal magnification to show the desired waves on a record of convenient size. Often this amounts to a slight compression rather than a magnification. As already explained, horizontal magnification is determined by the ratio of film speed to tracer speed, and this ratio can be selected independently of the vertical magnification.

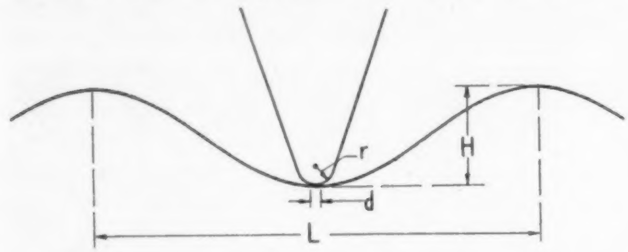

FIG. 6 SIZE OF TRACER REQUIRED TO BOTTOM IRREGULARITIES

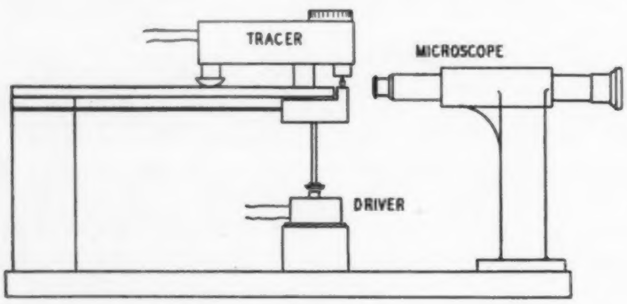

FIG. 7 METHOD OF CALIBRATING PROFILOMETER DIRECTLY IN INCH UNITS

At first thought, recording all surfaces to the same scales might seem desirable so that direct comparisons would be possible. This is feasible if the surfaces are of essentially the same roughness but is manifestly impractical for all surfaces. Surfaces vary so much that a record as large as a billboard would be required on rough surfaces, while, for smooth surfaces, the traces would be too small for good observation. The practical method is to select the scales so that a record of convenient size, say 2 × 8 in., is obtained, and to select the horizontal and vertical magnifications so that the irregularities it is desired to measure appear as a convenient size on the picture. Ordinarily, the exposure time is the order of $^1/_2$ sec, but considerable time is spent in adjustment and development, so that some minutes are required for each record. Set-up time for different types of specimen may amount to several hours each. Requirements vary so much that giving general figures of this sort is impossible.

Calibration. Over-all calibration is made directly in inch units by the arrangement shown in Fig. 7. The tracer point is oscillated through definite displacements by an electrically driven reed. These displacements are observed and measured with a microscope, and the profilometer gain adjusted for direct reading. In this way, the conversion factor from microinches to volts of each tracer unit is measured directly, and the profilometer scales set accordingly. Tests show that the tracer units maintain their calibration for long periods unless they are actually damaged. For ordinary use, it is only necessary to calibrate the amplifier, which can be done in a few seconds by supplying measured voltages from an ordinary 110-volt 60-cycle line or other convenient source. An adjustment of amplifier sensitivity is provided, although tests over a period of

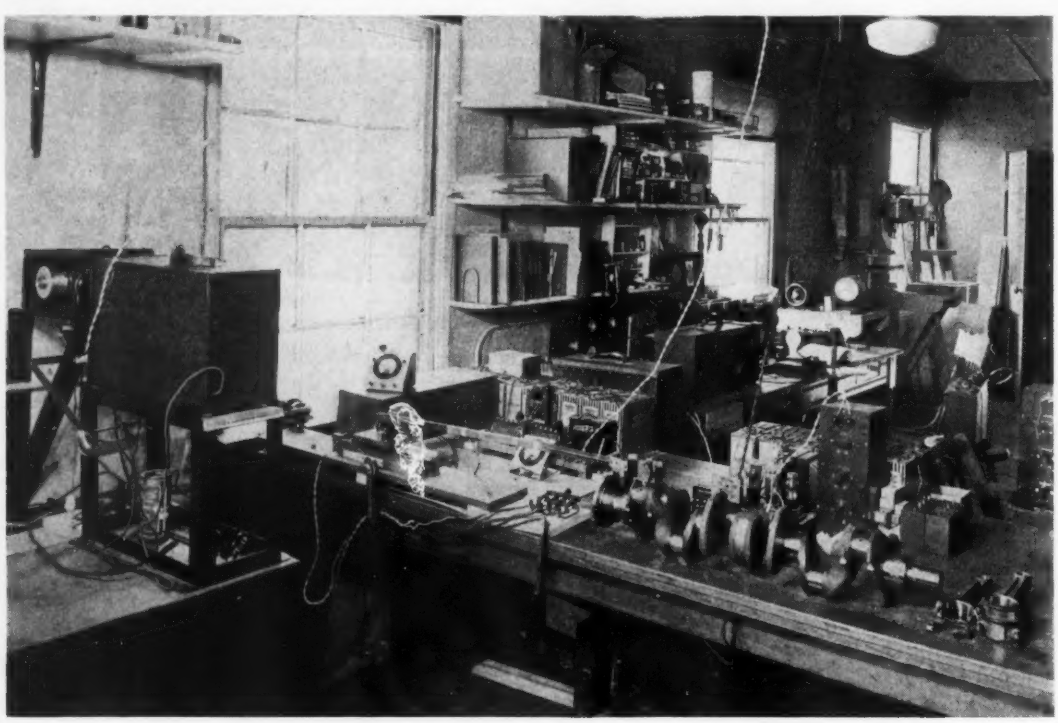

FIG. 8 SETUP FOR MEASURING BEARING SURFACES ON CRANKSHAFT

two years show negligible drifts in the amplifiers used. In this way, calibrating all instruments directly in inch units is a comparatively simple matter the microinch being used for convenience. Several of these instruments have been built, and the calibrations can be maintained within a few per cent.

Tracing Means. For cylindrical work, it has been feasible to mount the tracer rigidly and to turn the work past it. Well-fitted plain bearings operate surprisingly well on the work spindle. Necessary speeds are only a few hundred revolutions per minute or less, and, with careful balance, difficulties introduced by extraneous vibration can be made negligible. For most surfaces, particularly where high horizontal magnification, about 100, is necessary to measure roughness, it is feasible to mount the tracer on the end of an arm and to move the arm support on some sort of slide. Fig. 8 shows a photograph of one of our early experimental setups for measuring the surfaces of crankshaft bearings. Excellent results were obtained with this crude setup. The specimen was placed on an ordinary wooden table, which rested directly on a rather flimsy wooden floor on the second story, and no extraordinary difficulties were encountered. The ease with which measurements were taken under these unfavorable conditions illustrates that unusual precautions against extraneous effects are unnecessary. Size and design of the tracer unit make it adaptable to measurements on nearly any part of any surface. For measurements inside small holes, we have used extension adapters on the tracer. Taken all in all, the profilometer appears to meet satisfactorily the seven requirements that have been mentioned and to be a useful method for studying surfaces.

SEPARATION OF ECCENTRICITY FROM SURFACE CHARACTER

At first thought, the ideal profile record might appear to be one that would reproduce all irregularities in true proportion. Practically, such is not the case. Mention has been made of the practical value and necessity of horizontally compressing records several hundred times to obtain a useful amount of surface on a record and to be able to see the vertical dimensions of the waves. Other forms of selection are equally useful.

Consider for a moment, the situation illustrated in Fig. 2. It is rather difficult to mount a cylindrical specimen so that its eccentricity is less than 0.0001 in. (100 microinches). Hence, a true profilogram of its surface would show a large wave 100 microinches high. If one wished to measure roughness of the order of 3 or 4 microinches, this would be entirely obscured by the huge displacements due to eccentric mounting which are not a surface characteristic at all. The profilometer furnishes a simple and effective means for eliminating the effects of such eccentric mounting so that the smaller roughness can be accurately measured.

Fig. 9 shows the calibration curve of our first profilometer. When the tracer is held stationary on the surface, no reading is obtained which is an excellent test for extraneous vibration. When the tracer is moved across the surface, indications are obtained which are proportional to the displacement of the tracer point.

As can be shown by the flat part of the curve, these indications are completely independent of the speed of the trace, provided a certain threshold speed is exceeded. In this instrument, this speed corresponds to about 20 vibrations per second. For slower movements, the indication is practically nil. On ordinary surfaces, roughness scratches are about 0.002 in. in width so that a speed of trace of say $^1/_2$ ips would correspond to 250 vibrations per second which is well within the working range of the instrument.

If now a cylindrical specimen is rotated at about 5 rps, displacements resulting from eccentric mounting come well below

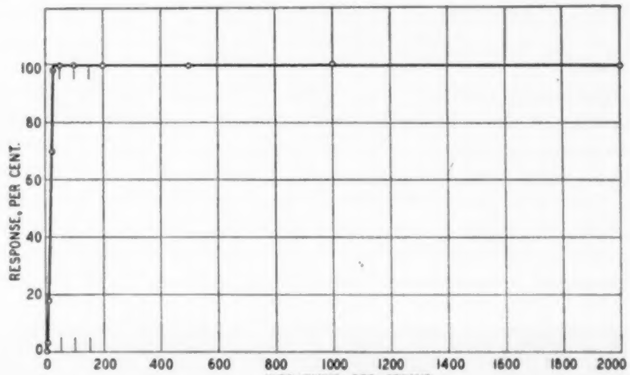

FIG. 9 CALIBRATION CURVE OF THE FIRST LABORATORY PROFILOMETER

the "cutoff" of the amplifier shown in Fig. 9 and hence do not appear on the record. This allows roughness and waviness shorter than $^1/_4$ revolution to be measured in true proportion without being affected by the eccentric mounting. All of the circumferential records shown in this paper were taken with the aid of this most convenient means of separating wanted from unwanted displacements. On the other hand, if one wishes to measure the eccentricity and longer waves, it is only necessary to increase the speed until these displacements come within the working range of the instrument.

SPECIAL CIRCUITS SEPARATE DIFFERENT IRREGULARITIES

We have just seen how the characteristics of the profilometer circuit can be used to separate effects of eccentricity from actual

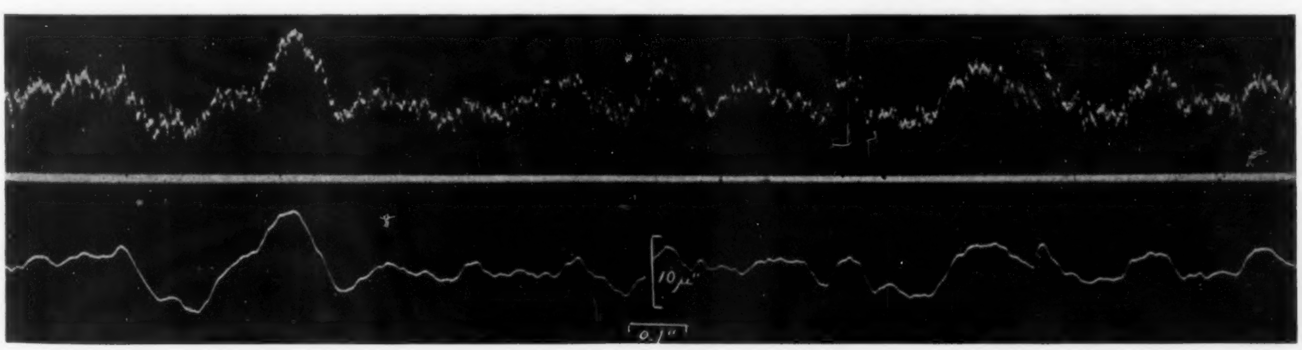

FIG. 10 PROFILE RECORDS ILLUSTRATING HOW PROFILOMETER CAN BE MODIFIED FOR MEASURING VARIOUS IRREGULARITIES

(Upper curve, actual surface, showing both waviness and roughness; lower curve, record taken to show waviness only. Original copy with magnification V = 50,000 and H = 4, reduced to $6^3/_4$ in.)

surface irregularities. Equally valuable is the ability to modify the profilometer circuit to separate different types of irregularities that exist simultaneously on a surface. The upper part of Fig. 10 shows a circumferential record on a typical wrist pin that has both roughness and waviness. The former is about 1 to 5 microinches in total height, and 0.003 to 0.010 in. in width, while the latter ranges from 3 to 15 microinches in total height and 0.025 to 0.250 in. in width. It is almost certain that these two types of irregularity are caused by different elements in the finishing process and that these two sources of

FOR A SINE WAVE THE rms VALUE IS $\frac{1}{2\sqrt{2}}$ (ABOUT $\frac{1}{3}$) THE PEAK TO VALLEY DISTANCE

FIG. 11 RELATION OF ROOT-MEAN-SQUARE AVERAGE TO TOTAL DISPLACEMENT OF SINE CURVE

error must be worked on separately. Determining the amount of one of these is hard if variations in the other are large. Hence, it becomes a practical necessity to separate them and make individual measurements on each.

The lower part of this illustration shows how easily this can be accomplished by using special circuits, indicated in Fig. 1, in the profilometer. In this curve, waviness is recorded unaffected, while the effect of the roughness is completely removed in the profilometer, the actual piece remaining unchanged. It is equally simple to remove the waviness and have only the roughness. This example is given by way of illustration, and by no means exhausts the possibilities of this type of diagnosis. On the basis of our experience to date, not only can we measure any type of surface irregularity that is important in practice, but we can also separate particular types of irregularities out of a complex contour that practically obscures them. The profilometer is an extremely flexible and powerful tool for measuring surface characteristics.

RATING SURFACES

In comparing surfaces, one immediately finds need for numerical ratings, preferably a single number. Studies of actual surfaces prove that surface irregularities differ greatly in character as well as in magnitude and no single number can hope to describe these differences. Experience shows that different surface characteristics are important in different applications, and consideration proves conclusively that no single number can satisfactorily rate surfaces for all purposes. However, one method of rating surfaces fills the need in a surprising number of instances, and this rating can be read directly on the profilometer.

Fig. 1 shows a meter that reads the average voltage output of the amplifier. If the surface is reasonably uniform and a long-period meter is used, this instrument gives essentially a steady reading throughout the trace. By suitable calibration (Fig. 7), this meter can be scaled directly in microinches, and the readings used as a measure of the surface. In the last two years, we have taken thousands of such meter readings on a wide variety of surfaces, both with and without profile records. This measurement is the most useful single number for rating a surface, and, time and time again, we found ourselves turning from pictures to meter readings in making comparisons. Again and again, we have found that these numbers agree with observations made by our clients and their experience with surfaces in application.

Readings of this meter are called "microinches—root mean square" and represent a running average of the height of the surface irregularities. For ordinary surfaces, usual speeds of trace produce an average over about $^1/_8$ in. of surface and thus includes several score of individual wiggles. As the trace progresses, the averaged area shifts continuously and the meter shows a continuous running average. If the surface is uniform, a steady reading is obtained. If the surface is not uniform, magnitude of the point-to-point variations can be estimated from meter fluctuations. Isolated scratches are not correctly measured, but their presence is clearly indicated by sudden jumps of the meter. If one wishes to measure such scratches, rather than average values, the meter can be modified.

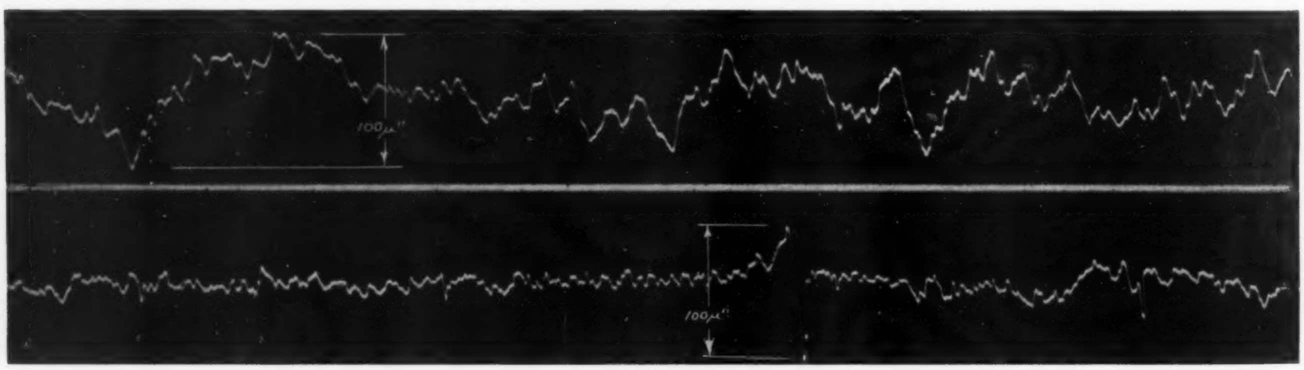

FIG. 12 AVERAGE VALUE VERSUS TOTAL HEIGHT OF PROFILE

(Both profiles have the same total height, but the lower has the smaller average.)

In all oscillating quantities, such as electrical voltages, currents, sound pressures, vibrations, and the like, root-mean-square values are customarily used. Mathematically, this means that the average is taken by squaring the instantaneous values, computing their average, and then taking the square root. This procedure tends to give more weight to the larger displacements in comparison with the smaller wiggles. While this may sound complicated in theory, it is simple in practice, as ordinary electric meters take this type of average automatically.

Fig. 11 shows the relation between total displacement and root-mean-square value for a sine wave. If the maximum deviation from the average line is 100 units, or 200 units peak to valley, it can be shown mathematically that the rms value is $100/\sqrt{2}$ or 70.7 units which is approximately one third of the peak-to-valley distance. On more complex waves, experience

has shown that the root-mean-square value is about one fourth to one third of the total height of the profile if the surface is fairly regular.

Fig. 12 illustrates the practical value of using averages for rating surfaces rather than the total height of the profile. Both surfaces have identical total heights, 100 microinches. The upper curve is consistently rough, while the lower has a single large irregularity, and the remainder of the surface is much smoother. While in certain applications, this single irregularity would determine the usefulness of the surface, the evidence is overwhelming that, in most applications, relative acceptability of the surface is more nearly given by the average readings listed. As previously mentioned, the presence of the single irregularity could be noted on the profilometer, and, if necessary, rated separately by microscopic or other means. Practical value of rating surfaces, in terms of microinches, has been demonstrated in production, and the method is rapidly finding wider application.

METER READINGS VERSUS PICTURES

Thus far, the paper has been concerned primarily with means for obtaining profile records of surfaces. Such pictures yield information that is not obtainable by other means and have given definite answers to a large number of important questions concerning surfaces. At first thought, such pictures might appear to be the whole story of surface measurement, but our experience has shown that they occupy a minor position. Pictures are important, but meter readings are many, many times more useful.

The first few profile pictures that one obtains on a surface, or group of surfaces, are enlightening and valuable. As more variables, such as change of speed, feed, tool, abrasive, and similar factors, are investigated, complications increase. When one spreads several hundred pictures before him and tries to determine the effects of a series of experiments, he soon finds himself hopelessly tangled. Every curve is different, and he is at a loss for means to express these differences. Immediately, he needs numbers to describe the differences in magnitude and character of the surfaces. Attempts have been made[5] to derive numbers from the curves to express essential characteristics, but endeavors to apply these methods to actual jobs are discouraging.

Even if time and expense were no object, untangling the desired information from profile pictures is next to impossible, and developing a different attack has been necessary. When time and expense are also considered, the need for better methods is even more vital.

Previously described microinch-root-mean-square meter readings form the starting point for the new method of rating surfaces. In fact, such readings are useful in themselves for giving an over-all rating of a surface, and in making comparisons between surfaces if the differences are large. Unfortunately, many practical jobs require measurements of surfaces that differ considerably in character without greatly affecting the total microinch reading. For example, consider the surface shown in Fig. 3. As mentioned previously, this surface has four more-or-less distinct types of irregularities that are all about the same height. To obtain definitely smoother pieces, it would be necessary to reduce all four of these types of error. Most likely they are due to different causes, and work on the individual sources would be necessary. Determining the effects of any change in the method of producing these surfaces would be difficult because the effect on each type would be more or less obscured by differences in the others, particularly if sample-to-sample variations were large. Obviously, total microinch readings would be of little use in diagnosing this problem and in determining the comparatively minor effects of individual changes necessary to the solution. Such jobs can be handled rapidly and accurately by modifying the profilometer so that it sorts out the things to be measured and measures them one at a time. Pictures of these individual parts can be taken if desired, but usually they are not nearly as useful as the meter readings. Obviously, preliminary work is required to determine just what must be measured for the job at hand, and then additional work is necessary to modify the equipment to take those desired measurements.

[5] "Technische Oberflächenkunde," by Gustav Schmaltz; Julius Springer, Berlin, 1936, pp. 112–124.

As a matter of exposition, it is not nearly as simple to describe this method as to say, "Just take the profile record. The story is there." The statement is true enough, but, practically, the information is likely to stay in the curve because getting it out to use is impossible. On the other hand, properly taken meter readings do not require next-to-impossible unscrambling. This was done by the equipment, and the meter readings apply directly.

Because of its extreme flexibility for solving a variety of practical problems, describing the details of the analyzing-meter method is hard, but it will solve problems which are untouchable by other means. This has been demonstrated on actual jobs.

SUMMARY ON LABORATORY PROFILOMETER

A profilometer of the general design described is a flexible and powerful tool. Naturally, it has its limitations as well as its advantages. The greatest limitation is that it is essentially a high-speed device and cannot be used for static measurements of dimension. To obtain correct readings, it must pass over the irregularity to be measured in 0.05 sec or less, so that it is not suitable for measuring long curves and single irregularities for which other means are available. The profilometer is particularly designed for a different purpose, the measurement of the finest irregularities in a large expanse of surface in a short time.

Among the characteristics of the profilometer are

(1) Sufficient sensitivity to measure the smoothest metal surfaces available today. Range and ruggedness of the instrument allow surfaces 1000 times as rough as these to be measured with the same setup.

(2) Available magnification is far greater than is possible with the best microscopic equipment.

(3) High vertical and low horizontal magnification, which is a necessity for surface work, can be easily arranged for.

(4) It is essentially a high-speed device capable of making traces 1000 times as fast as previous instruments.

(5) A continuous running average of the height of surface irregularities can be taken automatically and rapidly on almost any surface. The number obtained in this way is the most useful single number yet devised for rating a surface and is a sufficient rating for many purposes.

(6) Presence of individual scratches and other unusual irregularities is indicated.

(7) The instrument is calibrated directly in inch units. For convenience, the microinch is used.

(8) Exploratory measurements can be made quickly over large areas, and typical portions can be selected for pictorial records.

(9) Pictures of profiles can be made if desired and at higher magnification than with other available equipment.

(10) Profile records can be taken in fractions of a second compared with minutes with previous instruments.

(11) Cutting small specimens from large pieces is not neces-

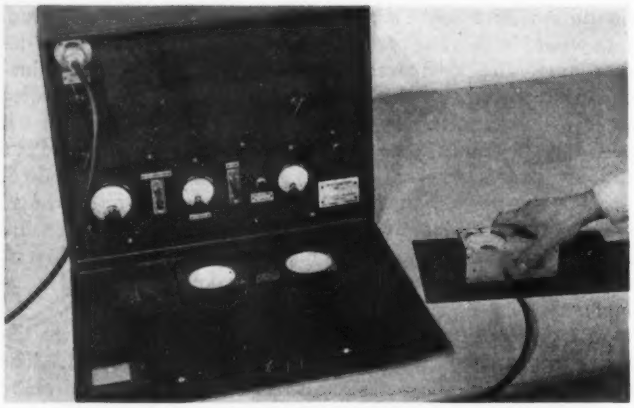

FIG. 13 SPECIAL-PURPOSE PROFILOMETER FOR PERMANENT INSTALLATION ON WINDSHIELD-GLASS PRODUCTION LINE

sary Measurements can be made directly on almost any surface.

(12) No damage whatever is done to the specimen, and the tracer point lasts indefinitely.

(13) Measurements can be made on curved and eccentric pieces without these characteristics affecting either reading or record.

(14) The instrument can be modified to focus its attention on given types of irregularities and to disregard other types.

(15) By making proper preliminary studies, the instrument can be modified to read directly, in microinches on a meter, the types of surface irregularities in which one is interested.

(16) Diagnosis of causes and cures for surface irregularities by the methods just mentioned is of great value on practical problems. This method is far more effective than profile pictures, although both can be used if needed.

PROFILOMETERS FOR SHOP USE

A principal objective of our work on the profilometer was to develop an instrument suitable for shop use. The practical requirements of such an instrument are somewhat as follows:

(1) Portable and self-contained
(2) No damage to specimen
(3) Direct and continuous reading
(4) Indications to be typical of a considerable area of surface
(5) Applicable to almost any size or shape of work
(6) Range sufficient to cover fine-finish and coarse-roughing operations (1 to 1000 microinches)
(7) Accuracy within between 5 and 10 per cent throughout this range
(8) Rating number given in standards units, preferably the inch
(9) Readings not affected by surface curvature
(10) Simple to operate
(11) Rugged and reliable
(12) Cost commensurate with delicate instruments now in use

Apparently the profilometer can meet these requirements, both for routine inspection and for general use.

Our first application was on routine production. A manufacturer of windshield glass wished to hold limits on the smoothness of the grinding operation that preceded final polishing. The degree of polishing required had been found to depend upon the smoothness of the ground surface, and great savings were anticipated in polishing if the grinding were con-

FIG. 14 CHECKING AUTOMOBILE-ENGINE CYLINDER BORES WITH THE PORTABLE PROFILOMETER

FIG. 15 PORTABLE PROFILOMETER BEING USED TO CHECK BEARINGS ON AN AUTOMOBILE-ENGINE CRANKSHAFT

trolled. Fig. 13 shows the special-purpose profilometer that was designed for permanent installation. The instrument was mounted on a switchboard panel some 50 ft away, and conduit run to a small cabinet mounted on a post beside the line and containing a switch with an indicating light and the tracer unit shown in the hand. This unit contains both the tracer element and the microinch meter on which the readings are taken.

When it is desired to check the glass, the operator simply turns on the switch, and, as soon as the light lights, holds the tracer unit on the glass as it passes by. The reading, which is directly in microinches, is independent of the speed of the glass. This installation has been in use for over a year on 24-hr service, and repairs to date consist of a broken lead wire and a supporting spring for the tracer which was broken by a curious workman. Notable reductions in polishing costs have been achieved by control of the grinding operation.

Figs. 14 and 15 illustrate measurements being made in an automobile plant with our first portable profilometer. Nearly a thousand surfaces were checked in two days and important changes in production methods made as a result. Data on these and similar tests may be released later by the client.

Fig. 16 is a general and Fig. 17 a panel view of the standard portable profilometer. The tracer is about the size of a box of safety matches and can be held in the hand for most work. Readings obtained are independent of the speed of trace, and the tracer can be mounted on an arm and moved mechanically if desired. Readings are taken directly in microinches root mean square on the large meter at the right of the panel. Full-scale ranges of 3, 10, 30, 100, 300, and 1000 microinches are provided. The meter at the left is used for calibration from a 60-cycle light line and for checking batteries. The unit is portable and self-contained and weighs 50 lb. A nonspillable storage A battery is included with an auxiliary unit for charging. Dry B batteries are used. Fig. 18 shows the instrument closed ready for transportation. Instruments of this type have been used in the shop for some months with excellent results.

FIG. 18 PORTABLE PROFILOMETER CLOSED FOR CARRYING

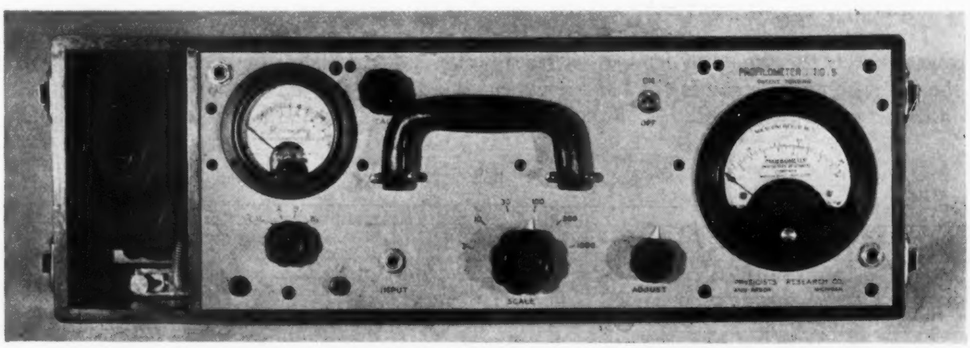

FIG. 17 PANEL VIEW OF PORTABLE PROFILOMETER
(The meter at the right is calibrated in microinches, and that at the left is used for calibration and checking over.)

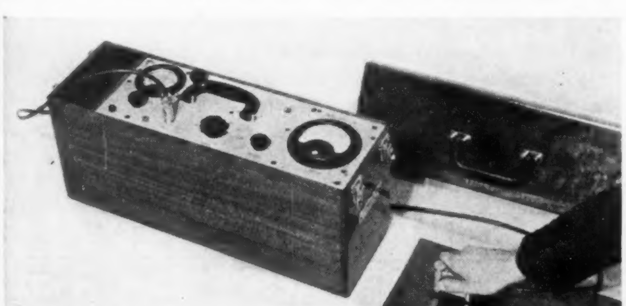

FIG. 16 TYPE-P PORTABLE PROFILOMETER
(The tracer unit is being held in the operator's hand.)

On many applications, particularly for routine production, it is anticipated that special-purpose instruments built for the job will be most practical. Such instruments could be made with special circuits and selector switches for measuring different types of irregularity.

SUMMARY ON PORTABLE PROFILOMETER

A year ago, measurement of microinches emerged from the laboratory and took its place in the shop. The instrument is about as difficult to use as a micrometer and can be used on a variety of work. In its present form, it is designed to measure roughness, irregularities up to about $^1/_{32}$ in. in width, but it can be adapted to measure waviness or other types of irregularity. Modifications probably will be required for the many uses to which it will be put, and the true value will be demonstrated in actual production.

PROFILOMETER READS RUNNING AVERAGE OF HEIGHT OF SURFACE IRREGULARITIES

One of the principal advantages of the profilometer is the automatic-averaging feature. The needle does not move back and forth with every irregularity as it would with a dial gage. This would require several hundred oscillations per second, and the eye could not possibly follow them. Instead, the needle

stands essentially still on the dial, and the position of the needle indicates the average height of the surface irregularities.

Fig. 19 illustrates the action of the meter. The upper curve shows a typical section of profile having various degrees of roughness. This curve can be described approximately as follows:

Horizontal units	Approximate total height, microinches	Character
0 – 3	8	Fine roughness
3 – 7	8	Coarser roughness
7 –11	8 to 12	Varying roughness
11–14	8	Fine roughness
14–20	40	Very coarse
20–25	8	Finer
25–25½	40	Large irregularity
25½–35	12	Quite fine roughness

Experience has shown that the root-mean-square value of a typical surface profile is usually between one third and one fifth of the total height. This is entirely logical, as the average is taken from the middle line so that it could not possibly exceed one half. Further, all the irregularities are not of maximum size, and this fact reduces the average to about one fourth of the total height. The root-mean-square value of each horizontal section of curve *A* has been estimated on this basis.

Suppose, now, that the indicator meter on the profilometer has a comparatively short period, so that it averages the displacements in one horizontal division. Curve *B* shows the reading of the profilometer as the profile of curve *A* is traced. Starting at zero, the meter climbs to a reading of 2 and remains at this position until the trace reaches point 7. From 7 to 9, the reading slowly increases to a value of about 3 as the average roughness increases and then decreases again to a reading of 2 between points 12 and 13. The deflection then increases to 10 by the time point 15 is reached and remains at this value until point 19 is passed. From point 21 to 25, the reading is again 2 and a sharp kick occurs near point 26. From point 27 to 35, the needle is stationary at 3.

Now if a longer-period indicator meter be used, so that the running average is taken over 5 horizontal units instead of 1, the results are shown in curve *C*. It is seen that identical readings with curve *B* are obtained on the portions of the surface which are uniformly rough, but the change from one reading to another occurs more slowly. In particular, the effect of the single irregularity near point 26 is much less.

From both the short-period and the long-period meter, the following information is obtained concerning the surface. The over-all average height of irregularities is about 4 microinches root-mean-square, and the surface varies considerably from about 2 to about 10 microinches root-mean-square the roughest spot being in the middle. Near point 26, a narrow group of large irregularities occurs.

Ordinarily, the instrument is provided with a long-period meter which is most convenient for reading average values. If one is especially interested in variations of roughness over small distances on the surface, a short-period meter can be used.

The most useful characteristic of the profilometer is that it takes these averages automatically and thus gives an accurate, easily read, and repeatable rating of the surface directly in inch units. The indicator meter does not oscillate with the individual wiggles of the surface but gives a steady reading which is the average height of the surface irregularities.

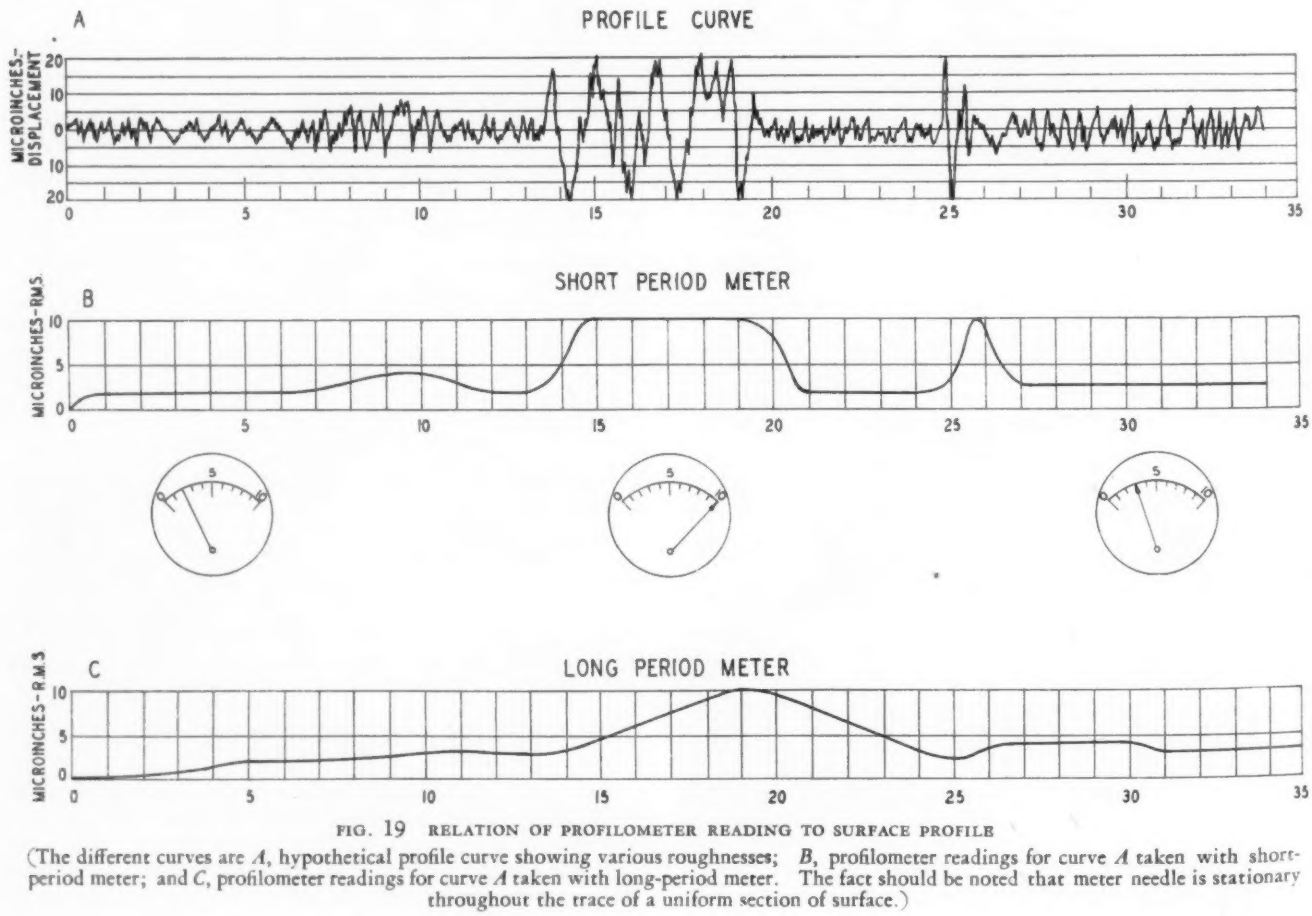

FIG. 19 RELATION OF PROFILOMETER READING TO SURFACE PROFILE

(The different curves are *A*, hypothetical profile curve showing various roughnesses; *B*, profilometer readings for curve *A* taken with short-period meter; and *C*, profilometer readings for curve *A* taken with long-period meter. The fact should be noted that meter needle is stationary throughout the trace of a uniform section of surface.)

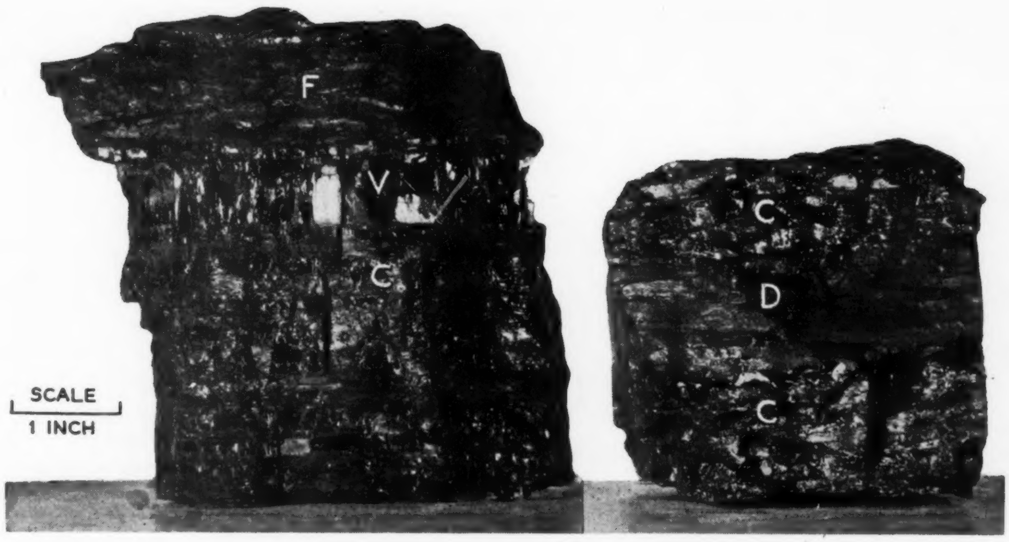

FIG. 1 TWO BLOCKS OF BANDED COAL FROM SOUTHERN ILLINOIS
(The four components, clarain, durain, fusain, and vitrain, are indicated by the letters *C*, *D*, *F*, and *V*, respectively.)

ILLINOIS COALS

Constitution Important With Reference to Their Utilization

By L. C. McCABE

ILLINOIS GEOLOGICAL SURVEY

MANY combustion problems of Illinois coals are related to the kind and quantity of bands in the coal beds and in the prepared coal. Such significant characteristics as ash content; fusion point of the ash; swelling, coking, and free-burning tendencies; friability; grindability; and Btu content are intimately related to the kind of bands making up the fuel. Importance may be attached to four distinct types of bands in Illinois coals in the order named; clarain, vitrain, fusain, and durain (Fig. 1). The glossy, finely laminated coal is clarain; the brilliant jet-black coal is vitrain; the dull laminated grayish coal, commonly known as splint, is durain. Fusain is the "mineral charcoal."

Relative proportions of the branded ingredients in No. 6 coal in Illinois are reasonably well-known but detailed information for the other workable coal beds is limited to a few mines. Clarain, however, is a predominant constituent in all coal beds of the state. Values obtained from measurements of the banded ingredients on polished surfaces of complete columns from the various coal beds are given in Table 1.

DESCRIPTION OF THE DIFFERENT COMPONENTS

The fusain content of No. 6 coal is highest on the western margin of the field and lowest toward the center and deeper parts of the basin. The clarain content is lowered appreciably by the presence of extraneous impurities and in two instances at least by the presence of durain. Vitrain shows a marked increase in quantity from the Belleville region in St. Clair County to Franklin County.

Proximate analyses of samples of vitrain, clarain, fusain, and durain in Table 2 show differences in the proximate values of the four ingredients which may exist in samples that were taken from the same mine. The two vitrain analyses are similar as are the two clarain analyses. Although the two fusain samples were collected in the mine on the same day and had identical preparation for analysis, they differ widely in moisture, ash, volatile matter, and Btu.

Fusain is the most porous of the coal components. Where ground water has access to it, the sample may contain considerably more moisture than the surrounding coal and ash-

TABLE 1 PERCENTAGES OF BANDED INGREDIENTS IN COLUMNAR SECTIONS OF COAL BEDS 2, 5, AND 6
(Each value represents an average of two determinations)

Coal bed	County	Banded coal ingredients: Vitrain	Clarain	Durain	Fusain	Banded impurities: Pyrite	Clay
2	Fulton	17.75	78.52	...	0.56	2.05	1.12
5	Saline	26.60	69.30	...	1.80	2.30	..
6	St. Clair	13.16	76.51	...	3.38	5.12	1.83
6	St. Clair	7.83	83.09	...	2.62	4.76	1.70
6	St. Clair	9.95	77.58	1.33	7.43	1.82	1.89
6	Montgomery	19.50	62.10	14.90	0.80	1.50	1.2
6	Washington	13.40	68.70	15.00	2.90	..	[a]
6	Randolph	14.76	75.88	...	4.77	..	4.59
6	Perry	19.00	69.90	2.60	4.50	..	4.00
6	Franklin	18.81	77.68	0.61	1.50	0.42	0.98
6	Franklin	22.70	72.40	1.60	2.30	0.10	0.90
6	Williamson	20.10	76.55	2.00	1.35	..	..

[a] 8-in. clay band removed in mining.

Presented at a meeting of the Chicago Section, Chicago, Ill., Oct. 19, 1937, of The American Society of Mechanical Engineers.

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forming mineral matter may be readily deposited from solution. In lenses closed to water, fusain usually has low ash and moisture. Volatile matter varies considerably but is usually much lower in fusain than in any of the other ingredients.

As vitrain was formed by coalification of the wood of the coal-forming plants, it is more homogeneous than coal formed from other parts of the plants. Because extraneous mineral matter has been excluded, an ash content of less than 1 per cent is not unusual.

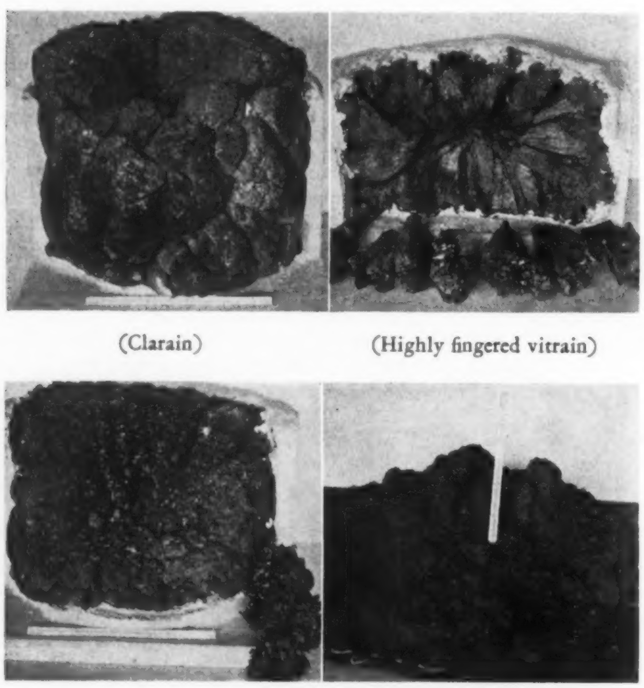
Clarain, formed from the coalified detrital materials of the coal swamp, such as leaves, twigs, bark, spores, and the like, has mingled with it the mineral matter that was present in the waters where the plant matter was deposited and usually has a considerably higher ash content than does vitrain. As the plant parts forming clarain are of a waxy or fatty nature, the volatile matter is usually higher than in vitrain.

Durain is of little significance in most Illinois coals, but when it occurs it may attain an importance out of proportion to its quantity because its "bony" appearance gives rise to the belief that it is essentially refuse. Frequently, however, the ash is low, and the durain has a much higher British thermal unit value than the other ingredients (Table 2). Practically without exception, durain has higher volatile matter than the coal with which it is associated. Like the clarain, it is formed from detrital materials but was probably formed during unusual conditions of deposition or by the preponderance of specific plant types.

TABLE 2 ANALYSES OF BANDED INGREDIENTS, COAL NO. 6, FRANKLIN COUNTY

Analysis number	Ingredient	Conditions	Moisture	Ash	Volatile matter	Fixed carbon	Sulphur: Sulphate	Sulphur: Pyritic	Sulphur: Organic	Sulphur: Total	Btu
C-510	Vitrain	a	8.87	0.87	35.60	54.66	0.00	0.18	0.49	0.67	13,010
		b	..	0.95	39.07	59.98	0.00	0.20	0.53	0.73	14,277
		c	..	..	39.44	60.56	0.00	0.20	0.54	0.74	14,415
		d	..	..	...	...	..	..	..	..	14,447
C-509	Vitrain	a	9.63	0.88	33.84	55.65	0.00	0.13	0.56	0.69	12,866
		b	..	0.97	37.45	61.58	0.00	0.15	0.61	0.76	14,237
		c	..	..	37.81	62.19	0.00	0.15	0.62	0.77	14,376
		d	..	..	...	...	..	..	..	..	14,411
C-503	Clarain	a	8.6	6.7	35.9	48.8	0.00	0.21	0.48	0.69	12,269
		b	..	7.3	39.2	53.5	0.00	0.23	0.52	0.75	13,426
		c	..	..	42.3	57.7	0.00	0.25	0.56	0.81	14,486
		d	..	..	...	...	..		..	..	14,600
C-504	Clarain	a	8.9	5.6	34.5	51.0	0.00	0.33	0.50	0.83	12,372
		b	..	6.1	37.9	56.0	0.00	0.36	0.55	0.91	13,582
		c	..	..	40.4	59.6	0.00	0.38	0.59	0.97	14,471
		d	..	..	...	...	..	..	..	..	14,569
C-505	Fusain	a	8.99	16.91	22.35	51.75	0.01	0.24	0.15	0.40	9,335
		b	..	18.58	24.56	56.86	0.01	0.26	0.17	0.44	10,257
		c	..	..	30.16	69.84	0.01	0.32	0.21	0.54	12,597
		d	..	..	...	...	..	..	..	..	12,844
C-506	Fusain	a	22.80	4.86	6.78	65.56	0.01	0.21	0.13	0.35	10,737
		b	..	6.29	8.78	84.93	0.01	0.27	0.17	0.45	13,908
		c	..	..	9.37	90.63	0.01	0.29	0.18	0.48	14,842
		d	..	..	...	...	..	..	..	..	14,937
C-1790	Durain	a	3.1	3.7	47.6	45.6	..	..	..	1.12	14,012
		b	..	3.8	49.1	47.1	..	..	..	1.16	14,460
		c	..	..	51.1	48.9	..	..	..	1.20	15,034
		d	..	..	...	...	..	..	..	..	14,630

[a] Moist bands as collected in the mine.
[b] Moisture-free.
[c] Moisture-and-ash-free.
[d] Unit coal Btu (dry, mineral-matter-free).



(Clarain) (Highly fingered vitrain)

(Weak granular durain) (Incoherent fusain after attempted coking)

FIG. 2 COKES MADE FROM THE FOUR INGREDIENTS

TABLE 3 ASH-SOFTENING TEMPERATURE OF COAL COMPONENTS, DEGREES FAHRENHEIT

	Mine A Illinois	Mine B Illinois	Mine C Illinois	Mine D Utah
Vitrain	1810	1906	2023	
		1918	1927	
		2084	2260	
Clarain	2130	2617	2073	2131
			2206	
Fusain	2270	2638	2565	
			2732	
			2349	
Durain	2540		2732	2440

Ash-softening temperatures of different ingredients from the same mine may be several hundred degrees apart. However, the data in Table 3 suggest the following order of increase in softening temperatures of ingredient ash; vitrain, clarain, fusain, and durain.

Ease with which the bands grind shows a wide difference. Durain is difficult to grind, clarain is less difficult, vitrain grinds easily, and fusain offers little resistance. These are important considerations where the coal is powdered before firing, and the cost of grinding must be considered.

Fig. 2 shows cokes made from the four ingredients. About 15 lb of each type of coal was sealed in separate metal containers and coked in a gas-fired furnace. A pipe leading from the top

of each container permitted the escape of gas and tars. When the thermocouple at the center of each batch showed a temperature of 900 C, the coke was quenched. Vitrain (top right) showed the greatest expansion during coking but shrank and fingered badly when quenched. Clarain (top left) swelled considerably less and showed much less tendency to finger. Durain (lower left) had poor agglutinating qualities and the coal particles had practically no coherence. Fusain (lower right) gave off little gas and tars and was essentially in the same physical condition after firing as when it was charged. While fusain lacks positive swelling and agglutinating characteristics, it is useful in blocking up or reducing fingering in high-vitrain coal used for coking. The structure of the clarain, vitrain, and durain coke is best shown in the sections embedded in plaster of Paris (Fig. 3).

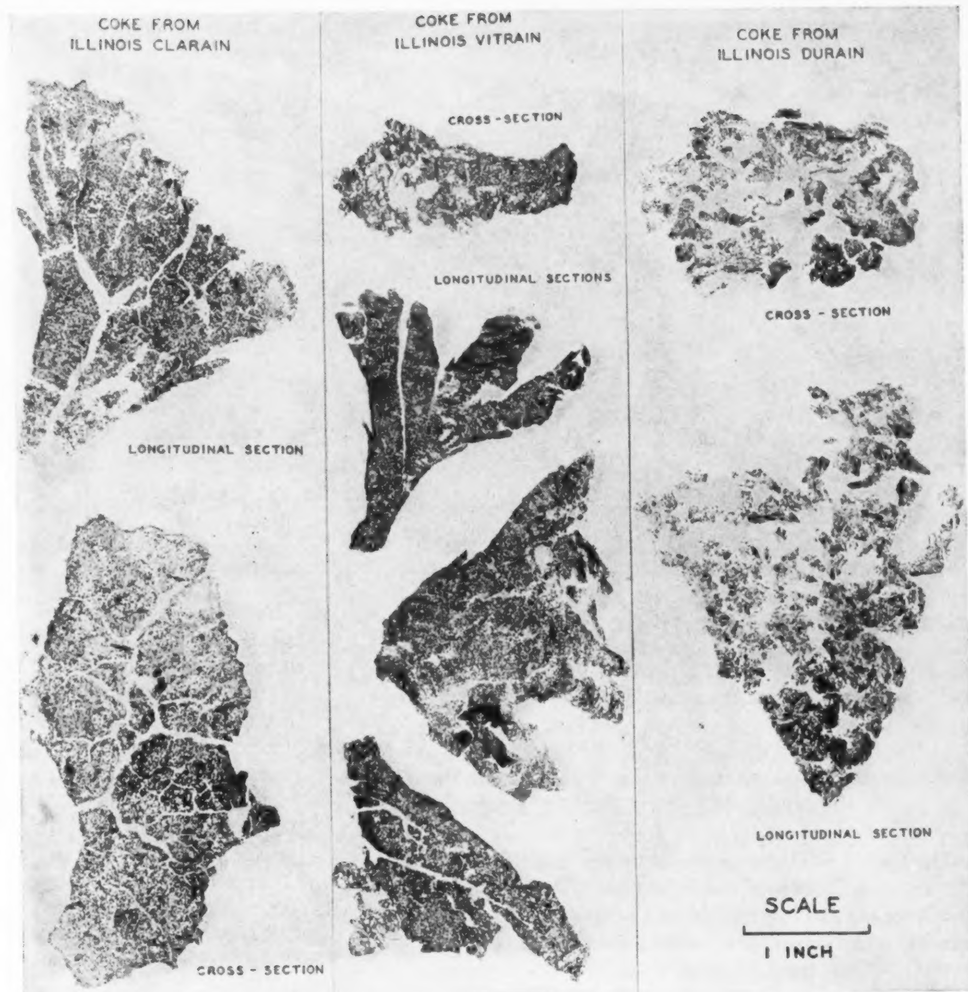


FIG. 3 SECTIONS OF COKE EMBEDDED IN PLASTER OF PARIS TO SHOW DIFFERENCES IN STRUCTURE

BEHAVIOR IN MINING, SCREENING, AND SHIPPING

Physical behavior of the coal components in mining, screening, and shipping is important. If blocks of coal are examined it becomes apparent that, on the majority of them, the surface parallel to the bedding plane is covered with fusain (Fig. 4). Fusain is structurally the weakest of the four coal components and is primarily responsible for degradation. Occasionally blocks will be seen with one or both surfaces parallel to the bedding plane covered by vitrain (Fig. 5). Vitrain is more resistant to breakage than fusain but is much weaker than clarain. It is the secondary cause of breakage in mining and preparation. Clarain, on the other hand, is closely knit together and stands up well under mechanical handling. When durain is present, it is the toughest and most resistant component. These breakage characteristics have considerable to do with the kind of coal that goes into the prepared sizes. Both vitrain and clarain can be found in the lump, and most of the surface will have a thin layer of fusain on them where the lumps have split along fusain layers. Most of the fusain has broken off, however, and will be found in the screenings or, if the coal is dedusted, in the dust.

The 3-to-2-in. egg coal may have some of the smaller vitrain bands but for the most part is clarain. No. 2 nut, 2 to $1^1/_4$ in., is even richer in clarain. In most coals, No. 3 nut, $1^1/_4$ to $^3/_4$ in., is 8 to 10 per cent higher in vitrain than the coal bed from which it was mined. Vitrain continues to concentrate below 48 mesh in most cases until the 100- or 200-mesh size is reached. Below this, fusain is usually highly concentrated.

Washing may play a considerable part in separating the ingredients. In the $-1^1/_4$-in. screenings from one mine, 58.9 per cent of the coal floats at 1.30 sp gr. This coal is 58.2 per cent vitrain, 40.0 per cent clarain, 1.1 per cent fusain, and 0.7 per cent middling refuse. The average vitrain content of the coal bed is only about 20 per cent. This vitrain is so highly concentrated in the fraction floating at 1.30 sp gr that, as previously indicated, vitrain decreases and clarain increases in the nut and larger sizes. A microscopic analysis of a washed $^3/_8$-in. to 48-mesh coal from an Illinois mine showed the composition given in Table 4 in comparison with the coal in the seam.

TABLE 4 COMPOSITION, BY PERCENTAGE, OF A WASHED ILLINOIS COAL AND THE SEAM FROM WHICH IT WAS MINED

	Washed	Coal bed
Vitrain	40.8	19.0
Clarain	51.9	69.9
Fusain	2.6	4.5
Refuse	4.7	6.6

COMBUSTION TESTS

The foregoing discussion of the effect of sizing and washing and the chemical characteristics and distribution of the banded ingredients gives a generalized view of the information collected for conducting studies of how these different sizes, and, consequently, different mixtures of ingredients burn. Much of the uneven burning in the stoker fuel bed can be attributed

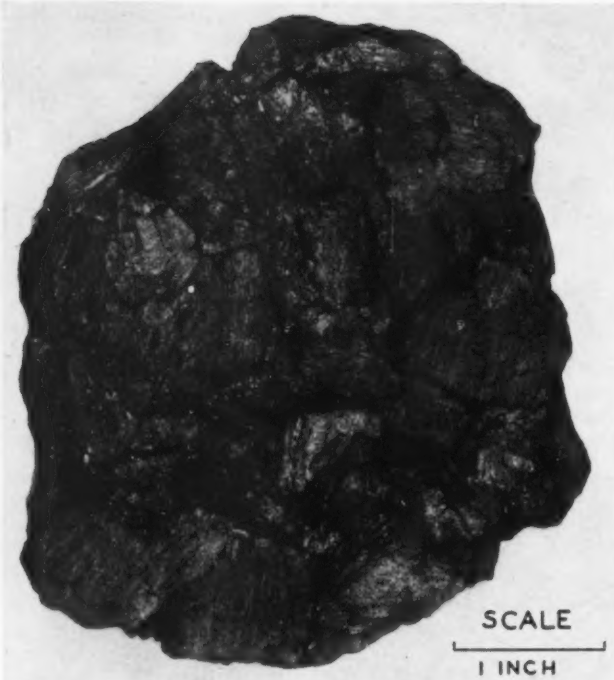


FIG. 4 FUSAIN AS IT OCCURS ON THE SURFACE OF A BLOCK

(Breakage readily occurs at such surfaces and the broken fusain concentrates in the form of 100- to 200-mesh dust.)

to the highly swelling nature of vitrain which our studies have shown to be concentrated in the stoker sizes. Crushing egg and large nut sizes, which have a great proportion of relatively free-burning clarain, and mixing this crushed coal with the normal stoker sizes or marketing the product as a special stoker fuel may be desirable for some mines.

In view of the different responses of the ingredients to coking and with a general knowledge of their distribution in prepared sizes, a study was made of the combustion in a domestic underfeed stoker of two of these types of coal, which were from the same mine. The $^7/_{16}$-in. to 10-mesh coal normally loaded at the mine was separated at 1.30 sp gr and the float was recovered to give a high-vitrain fuel, 70 to 75 per cent. The coal high in clarain was made by crushing the 2-to-$1^1/_2$-in. nut produced by the mine to —$^7/_{16}$ in. and screening out the —10-mesh dust. Screen analyses of the two coals as burned are shown in Table 5.

TABLE 5 SCREEN ANALYSES OF STOKER TEST COALS

(Each sample riffled from 100 lb of coal)

Screen size[a]	*A*	*B*
$+^1/_2$ inch	0.9	2.1
$^1/_2$ to $^3/_8$ inch	13.4	10.4
$^3/_8$ inch to 3 mesh	10.2	11.4
3 to 4 mesh	25.7	30.5
4 to 6 mesh	23.3	19.7
6 to 8 mesh	15.7	12.7
8 to 10 mesh	7.1	10.1
10 to 20 mesh	2.7	2.4
20 to 48 mesh	0.5	0.4
minus 48 mesh	0.5	0.3

A 1.30 sp gr float from $^7/_{16}$ in. to 10 mesh coal produced at the mine.
B 2 to $1^1/_2$ in. coal crushed to $^7/_{16}$ in. and 10 mesh removed.

[a] Round-hole screens used on sizes above $^3/_8$ in. Tyler standard sieves used on sizes below $^3/_8$ in.

Excessive swelling and coke-tree formation accompanied initial stages of combustion of the coal high in vitrain, as shown at the extreme left of Fig. 6. "Blowholes" appeared around the base of the coke tree (left center) and were present throughout combustion. When the coke tree reached the top of the furnace, it broke apart, and large blowholes were in evidence for some minutes (right center). As fresh coal was fed in, a swollen, plastic mass filled the firebox (extreme right). A satisfactory fuel bed did not develop at any time, and the furnace capacity was considerably reduced.

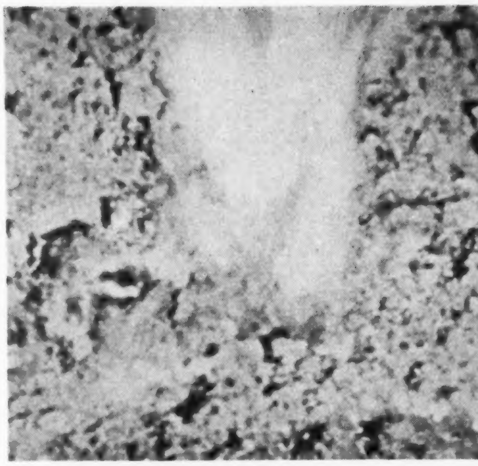
The left portion of Fig. 7 illustrates the first stage in the combustion of the high-clarain fuel. No excessive swelling and coking occurred such as accompanied the burning of vitrain. The even burning during a late stage of the clarain fuel bed is shown at the right.

CONCLUSION

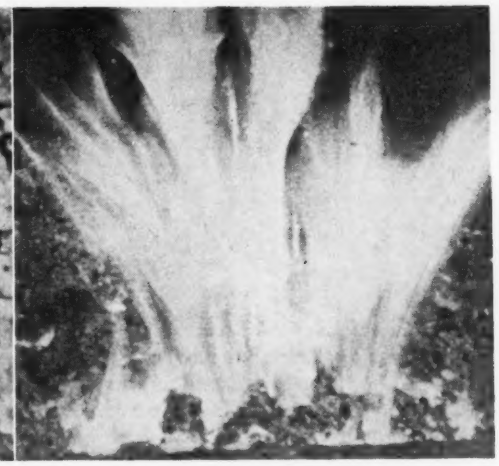
Banded coals of Illinois have three and sometimes four coal components which differ chemically and physically, frequently to such an extent that, should they be separated before market-

FIG. 5 LUMP OF ILLINOIS COAL THAT WAS BROKEN THROUGH A VITRAIN BAND

(Many small vitrain particles break free of the block and go into the small sizes when such breakage takes place. The lines in the background are spaced 2 in. apart.)



(Flame breaking through ash at start of combustion)



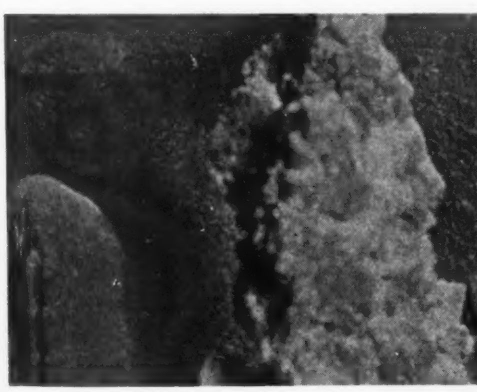
(Uniform fire in later stage)

FIG. 7 COMBUSTION OF HIGH-CLARAIN FUEL

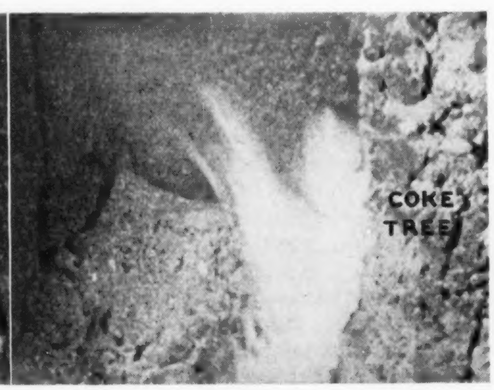
ing, the products would be regarded as distinctly different coals. Mining and preparation are responsible for a partial separation or segregation of the different types of coal now reaching the market. Friable vitrain and fusain are concentrated in the screenings and small prepared sizes, the latter reaching its highest concentration in the dust from dedusted coal. Clarain, and durain when present, comprise the greater part of the egg and nut sizes.

Of most immediate significance in the marketing and utilization of coals of this variety is the excessive swelling of vitrain and the relatively free-burning nature of clarain in an underfeed stoker. Screenings and the smaller stoker sizes, when high in vitrain, are likely to form coke trees and uneven fuel beds. Larger sizes, which are rich in clarain, when crushed to accommodate the small stoker, burn uniformly without excessive coking or swelling. In view of these combustion characteristics, it is sometimes advisable to crush and mix large coal with normal stoker sizes to obtain a fuel that burns uniformly.

Laboratory tests have brought out significant differences in the response of various types of coal to coking, in softening temperature of the ash, in grindability, and in proximate analysis. These data indicate that the banded coals here discussed lend themselves to a type of preparation that will yield fuels of a more uniform and desirable character.

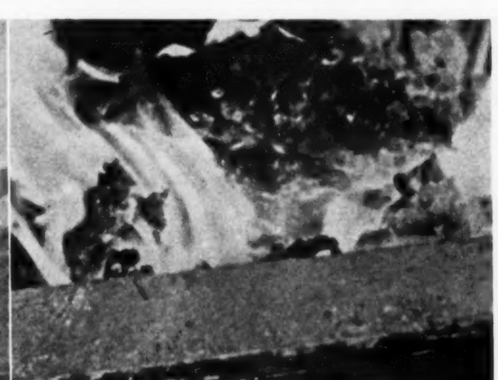


(Coke tree touching furnace top soon after beginning)



(Blowhole in base of coke tree)

(Close-up of blowhole in the fuel bed)



(Plastic mass that filled firebox in later stage)

FIG. 6 STAGES IN THE COMBUSTION OF A COAL THAT IS HIGH IN VITRAIN

INDUSTRIAL UNIONISM *in* ACTION

By J. A. BROWNELL

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IT IS REASONABLY safe to say that the Committee for Industrial Organization has been in the headlines of every important newspaper in the country every day for more than a year. It is likely, too, that only a minority of readers know anything of the history of that organization or of the forces which have been at work for many years within the labor movement and which finally resulted in the birth of the C.I.O. For those who wish to know more about the Committee for Industrial Organization, without going into a complete study of the history of labor in this country, J. Raymond Walsh's recent book "C.I.O. Industrial Unionism in Action"[1] provides a well-written and readable study of events in the past two years, with a brief history not only of the labor movement in general but also of developments in some of the more important industries.

Mr. Walsh makes no attempt to hide his sympathies for the C.I.O. or his impatience with the ardent craft unionists in the American Federation of Labor; and he becomes bitter when referring to some of the more militantly anti-union employers and to their methods. He is, however, most careful to produce substantial supporting evidence whenever his personal convictions lead him to take a particularly emphatic stand.

EARLY STRUGGLES OF ORGANIZED LABOR

In his first two chapters Mr. Walsh discusses the early struggles of organized labor for recognition in the United States. Of the many unions which rose in the last sixty years the only important organizations which survived the World War were the American Federation of Labor and the independent railroad unions. Organized strictly on craft lines, membership in the A.F.ofL. was chiefly the "aristocracy" of labor, the skilled worker. In the early days there was good reason to exclude the unskilled workers who were largely immigrants with many racial differences and no national or sympathetic feeling to unite them and keep them united; but this reasoning has gradually lost validity. Developed by Samuel Gompers, the policies, which for a long time gave the A.F.ofL. its power, gradually became a source of weakness as the mass-production industries gradually increased and immigration declined.

Since 1900, a strong minority in the A.F.ofL. has persistently advocated industrial unionism. In practice frequent concessions have been made to this group, although in principle the majority has always forced adherence to the craft structure. The outstanding exception has been the United Mine Workers which, since before the World War, has been a strictly industrial union. It is interesting to note, however, that the present leaders of both the A.F.ofL. and the C.I.O. spring from this union.

The prominence of the issue between craft and industrial unionists within the A.F.ofL. is emphasized in Mr. Walsh's book by the following quotation from a statement by William Green in 1917, when he was more interested in the affairs of the United Mine Workers than in those of the Federation as a whole. "The organization of men by industry rather than by craft brings about a more perfect organization, closer cooperation, and tends to develop the highest form of organization ... When men are organized by industries they can concentrate their economic power more advantageously than when organized into craft unions... The advantage of such a form of organization is so obvious that one can scarcely conceive of any opposition thereto.... In the development of industry and organization the tendency is toward concentration and perfection... Hence the reason why organized labor is gradually passing from craft organization to the more effective industrial forms of organization."

When N.R.A. became effective in 1933, its section 7A permitting "employees to organize and bargain collectively through representatives of their own choosing. . . free from interference, restrain or coercion," was the signal for the A.F. of L. to start a new drive to increase its membership which had fallen about fifty per cent in the previous thirteen years. In the next eighteen months membership was almost doubled and the greatest increases were in the industrial unions such as the United Mine Workers. No progress was made during this time, however, towards organizing two of the largest manufacturing industries in the country, steel and automobiles, except by a few independent organizations.

C.I.O. FORMED IN 1935

The A.F.ofL. convention in 1934 passed a resolution ordering the executive council to conduct a campaign of organization in the steel industry, but this was not carried out. In one case an independently organized union of steel workers applied to the A.F.ofL. for an industrial charter. Their reward was an influx of organizers from the separate craft unions who proceeded to split up the membership, each organizer signing up those that came under his jurisdiction. This policy resulted in complete breakdown of organization in that district. The fact is that until the C.I.O. was formed there was no group within the A.F.ofL. which had either authority or incentive to organize the mass-production industries. The executive board of the latter is composed of men more responsible for the interests of their own unions than for those of the Federation as a whole, and, in addition to lack of authority or money to conduct a unified organizing campaign in the larger industries, the A.F.ofL. officials found that the best interests of their individual crafts were often opposed to the general interests of the mass of workers.

The A.F.ofL. convention in 1935, by a small majority re-

(*Continued on page 234*)

[1] "C.I.O. Industrial Unionism in Action," by J. Raymond Walsh, W. W. Norton & Company Inc., New York, 1937.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers.

CONDITIONING FEEDWATER *for* STEAM GENERATORS

By CHARLES E. JOOS

COCHRANE CORPORATION, PHILADELPHIA, PA.

METHODS of conditioning boiler feedwater and equipment used have both been greatly improved and refined in recent years to meet the requirements of high-pressure boilers operated at high ratings. This paper discusses these requirements and describes the most advanced ways of meeting them from the plant operator's point of view. To select the most suitable and economical method for conditioning feedwater in a given plant, both the objective sought and the physical and chemical characteristics of the water supply must first be understood. A properly conditioned feedwater should give the following results, irrespective of the method used.

(1) Heating and evaporating surfaces of the boiler should be kept clean by reducing calcium, magnesium, and silica content of the water to low limits and adherence of precipitated solids or sludge avoided by maintenance of a suitable environment in the boiler. Presence of scale of even eggshell thickness in high-rating boilers may cause overheating and rupture of the tubes. The rate of flow of heat through surfaces exposed to direct radiation is such that any increase in resistance to flow from metal to water will result in a considerable increase in the temperature of the metal. At 1000-lb pressure, this temperature can be increased only 350 F above that of the water before failure occurs.

(2) The metal of the boiler must be protected against corrosion by maintaining a satisfactory hydrogen-ion concentration or pH value and by eliminating free oxygen from the water. Higher temperatures, cleaner surfaces, and purer feedwater all promote corrosion, making it necessary to reduce oxygen to low limits. Deaeration thus automatically becomes part of water conditioning. Thermal and mechanical means for eliminating oxygen are widely used, while chemical means, such as use of sodium sulphite or ferrous iron, have been used, either as an adjunct to softeners or independently.

(3) Carry-over of liquids or solids in steam leaving the boiler must be prevented. The first step to this end is to reduce and control solids and alkalinity in the boiler water. For smooth-boiling conditions, hydroxide alkalinity should be held to low values, while suspended solids should be reduced to the minimum by eliminating them from the feedwater or by a liberal blowdown schedule. Steam washers and purifiers or similar devices may reduce or prevent carry-over, but their task should be reduced as much as possible by chemical means.

(4) Embrittlement of boiler metal should be avoided by maintaining a suitable ratio of sulphates to carbonates in the boiler water, as recommended in the A.S.M.E. Boiler Code. For high-pressure boilers, this ratio is three parts of sodium sulphate to each part of sodium alkalinity expressed as sodium carbonate. To bring about this condition, alkalinity of the treated water, as well as its sulphate content, must be controlled. Maintenance of low boiler-water alkalinities is an economical way of obtaining the ratio, since reducing the alkalinity by 1 grain is equivalent to increasing the sulphate concentration by 3 grains.

Having stated the objectives, the next problem is to select the equipment and methods that will accomplish the desired results at minimum cost. Methods of treating water externally of the boiler will be described, as most water supplies are of such a character that outside treatment is preferable. Methods and equipment for external treatment may be classified as follows:

- Evaporators
- Hot-process softeners
  - Treatment by lime and soda ash with supplementary treatment by phosphate in the boiler
  - Softening by phosphate externally to the boiler
  - Primary treatment by lime and soda ash followed by secondary softening with phosphate externally to the boiler
- Zeolite softeners
  - Sodium zeolites
    1. Water fed directly to the boiler without other treatment preceding or following the zeolite softener
    2. Treatment with lime ahead of the zeolite
    3. Treatment with acid following the zeolite
  - Hydrogen zeolite
    1. Neutralization of water leaving the zeolite filter with alkali
    2. Neutralization by mixing water treated by hydrogen zeolite with other water treated by sodium zeolite.

Each process or apparatus has its particular application, determined by cost of equipment, operation, and installation, and, that selection may be intelligent, the advantages of each will now be outlined.

EVAPORATORS

Evaporators, properly operated, produce substantially pure feedwater, free of solids and scale-forming material, except for that which may be introduced by priming in the evaporator. Where, by reason of individual peculiarities of the steam-power cycle they can be operated economically, they may be preferred, particularly for boilers operated at extremely high pressures. General use of evaporators is confined chiefly to central stations, where the make-up constitutes but a few per cent of the total feed, but a number of installations have been made for supplying large percentages of make-up to boilers operated at pressures of 1200 lb per sq in. and above. In these instances, the designing engineers, by taking into consideration all of the factors, have undoubtedly justified their installation.

Evaporators, like all other methods of preparing water, entail a cost of operation. The mere fact that evaporators transfer heat without thermal loss does not indicate that pure feedwater is prepared for nothing. In an evaporator, the make-up is evaporated by steam exhausted or bled at a pressure higher

Presented at a meeting of the Philadelphia Section, Philadelphia, Pa., Nov. 23, 1937, of The American Society of Mechanical Engineers.

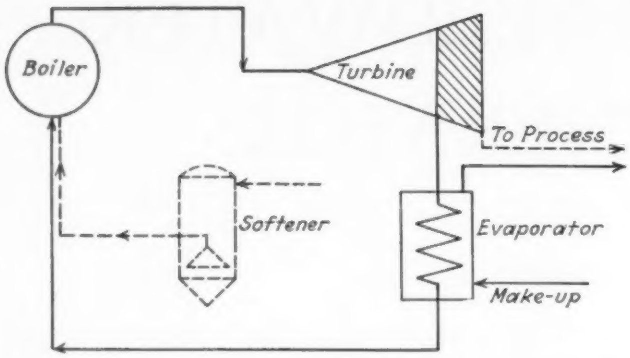


FIG. 1 POWER LOSS BY EVAPORATOR

than that of the make-up vapor; thus, if steam is to be generated for make-up at 100 lb per sq in., steam must be withdrawn from the power cycle at 150 to 200 lb per sq in. for the purpose. This drop in temperature head is part of the cost of preparing water. With an evaporator, steam must be bled from the turbine at a pressure higher than that at which it would otherwise be withdrawn for heating feedwater to a given temperature or for use in an industrial process. In Fig. 1, the shaded area represents the additional expansion that might be obtained from steam bled at a lower pressure where a softener is used instead of at a high pressure where the make-up is supplied by an evaporator, while Fig. 2 shows the power that can be obtained in passing 100,000 lb of steam from one pressure to another. This is a charge that is to be applied against evaporator operation. The particular heat cycle into which the evaporator is to be fitted must be considered, however, before the conclusion is drawn that evaporators are more expensive than other methods of conditioning feedwater. In some cases, they work out favorably; in others, chemical treatment is to be preferred as the method of treatment, especially for large quantities of make-up.

HOT-PROCESS SOFTENER WITH SUPPLEMENTARY PHOSPHATE FEED

The hot-process softener using lime and soda ash as reagents with a supplementary feed of phosphate to the boilers is illustrated in Fig. 3, which shows a softener of rather small capacity and in which deaeration is also provided. The raw water is

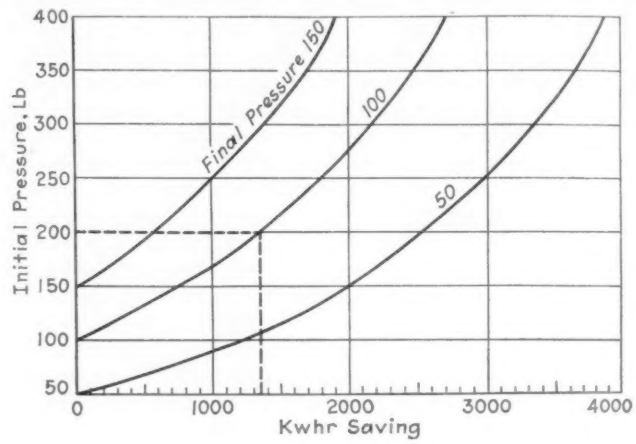


FIG. 2 POWER OBTAINABLE BY EXPANDING 100,000 LB OF STEAM PER HOUR

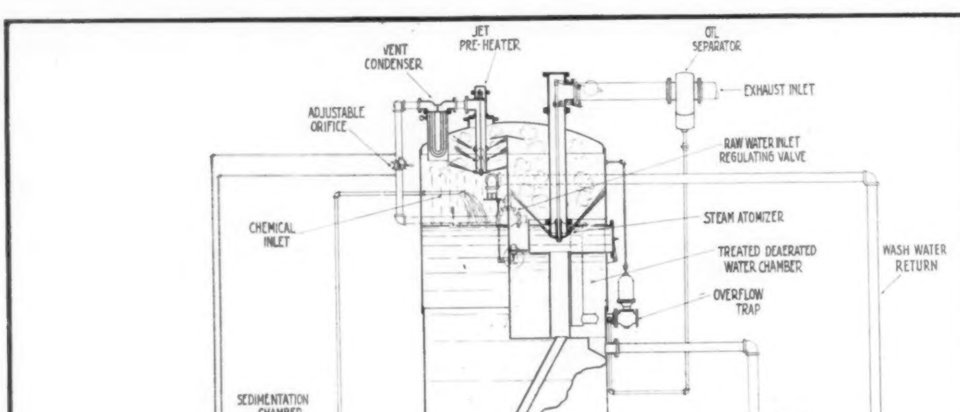


FIG. 3 HOT-PROCESS SOFTENER

(Lime and soda are used as reagents, with a supplementary feed of phosphate to the boilers.)

first preheated by spraying through a steam atmosphere, after which lime and soda ash are added directly below the heater, followed by sedimentation. It then flows upward to a deaerating compartment, where it is thoroughly atomized to remove all traces of oxygen. Finally, the water flows to a filter to remove finely divided suspended matter that has not settled out in the sedimentation tank. Phosphate solution is fed from a tank that is separate from the one which supplies the lime-and-soda-ash mixture and is pumped directly to the boilers, usually intermittently, or it may be pumped into the suction of the boiler-feed pump. Proportioning of chemicals and the entire operation of the softener is automatic, with the exception of the manual controls for backwashing the filters.

Operating in the manner described, this softener reduces the carbonates to low quantities, leaving no by-products and requiring no preparatory treatment, such as coagulation and filtration. The water supply may be taken directly from a river, such as the Schuylkill or Delaware, and softened and cleared up in one operation. It is the most generally applied type of softener and is commonly used in industrial plants for the higher boiler pressures, as 600 to 900 lb per sq in. Operated with only lime and soda, it reduces the hardness to low limits, approximately 1 to $1^1/_2$ grains per gal, depending upon the excess of chemicals added. A lower hardness can be obtained by using more chemical, but this is not generally considered good practice. The relationship between excess of soda ash and residual hardness is shown in Fig. 4, from which it will be seen that what is commercially designated "zero hardness" can be obtained by feeding approximately 50 ppm, or more, excess of soda ash. However, for high-pressure boilers, caustic alkalinity must be kept low for smoother boiling conditions and the establishment of a proper embrittlement ratio, for which reasons softeners of this type are generally operated with 20 to 30 ppm excess of soda ash, which gives a residual hardness of approximately 20 to 25 ppm.

Residual hardness carried in the effluent from a softener should be kept in such an environment that it will precipitate as a soft, nonadherent, easily flocculated sludge, while, at the same time, alkalinity of the boiler water should be held to the minimum for the establishment of embrittlement ratios and better steaming conditions. A number of supplementary treatments are available for attaining this end, the most common being the phosphates, which can advantageously be fed either as meta or monosodium phosphate, both of which have alkaline-reducing properties and will convert the residual calcium to nonadherent calcium-phosphate sludge.

The fact that the phosphate radical does not decompose as does the carbonate makes possible the maintenance of satisfactory conditions as to nonformation of scale in the boiler without an accompanying excessive alkalinity. This combination of equipment and process is particularly effective for handling turbid carbonate waters or waters that carry appreciable quantities of silica, as the precipitate resulting from the lime and soda ash has a screening action in bringing down the silica. Reduction in silica actually obtained in a number of industrial plants is shown in Fig. 5, from which it will be observed that the reduction in silica averages about 60 per cent. There is a similar screening or scouring action on organic substances. At the high rates of driving practiced with modern generators, silica should be reduced to low limits; otherwise, a thin tenacious scale of the sodium-aluminum-silicate type may form upon the evaporating surfaces exposed to intense heat. An examination of the results of lime-and-soda treatment of various waters indicates that the original magnesium content has much to do with the complete removal of silica. In one sample of water containing 130 ppm of magnesium carbonate which was treated with lime and soda ash, the silica was reduced from 26 to 1 ppm. The method of conditioning boiler feedwater just described is by far the most popular for steam pressures of 600 to 900 lb per sq in. and has given highly satisfactory results. Sludge resulting from the phosphate treatment is generally nonadhering and can be made less so by introducing colloids, such as tannins, starches, and the like. Their use, however, is the exception rather than the rule.

For treatment of hard waters, particularly those high in carbonates, the cheap reagents, lime and soda ash, are particularly well-adapted, the conditioning being completed with phosphate fed directly to the boilers. With soft waters having a hardness of less than 50 ppm, however, high efficiencies cannot be claimed for this method of treatment, since residual hardness, after the addition of lime and soda, may exceed this figure, and a more efficient precipitating agent is desirable, even though it may be somewhat more expensive. Soft waters, such as that from the Delaware River, can be treated

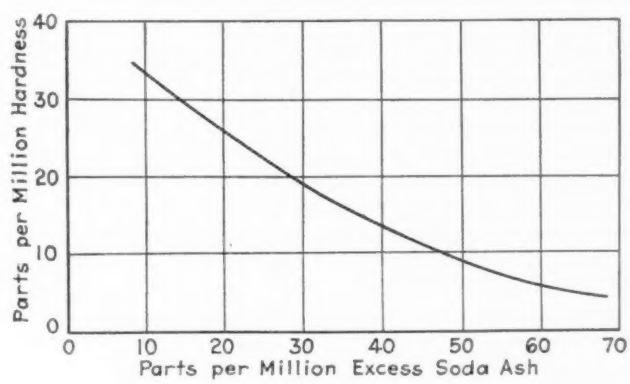


FIG. 4 RELATION BETWEEN EXCESS OF SODA ASH AND RESIDUAL HARDNESS

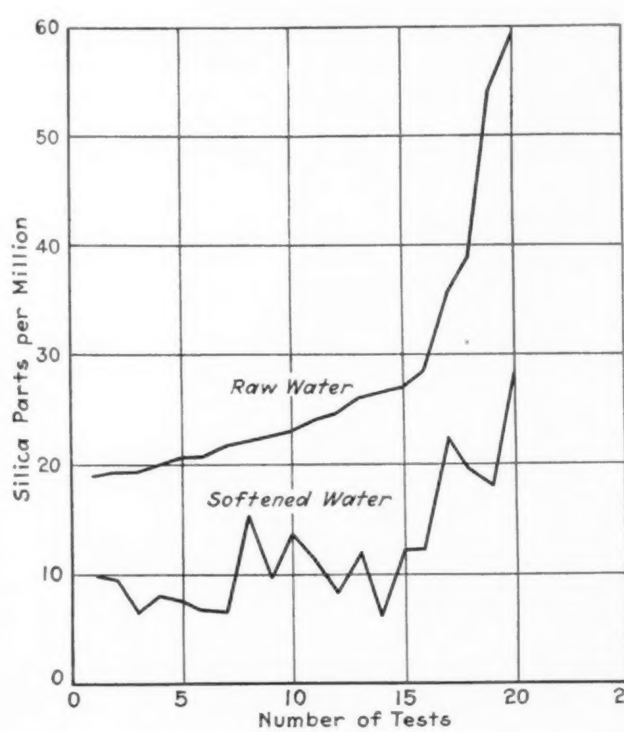


FIG. 5 REDUCTION OF SILICA BY LIME AND SODA ASH IN HOT-PROCESS SOFTENER

economically with sodium phosphate in combination with caustic soda, and, by the maintenance of a proper pH value and an excess of phosphate, the hardness can be reduced to a few parts per million. A good example of this method of water conditioning is at the plant of the Pennsylvania Sugar Company, where this method was preferred to lime and soda with supplementary phosphate treatment by reason of the simplified control and the smoother boiling conditions resulting from the elimination of boiler sludge. This plant was described in a paper[1] presented by Daniel Gutleben before the A.S.M.E. meeting at Niagara Falls in September, 1936.

TWO-STAGE SOFTENING

In most cases, water is softened more completely by phosphate treatment than by zeolite softening, but it is not practical to apply phosphate directly to waters of over 50 ppm hardness. With waters of high hardness, the treatment is, therefore, divided into two steps or stages, the first involving treatment either cold or hot with lime and soda ash and the second treatment of the decanted or filtered water with phosphate in a separate compartment or tank. This method has been followed in a number of high-pressure plants with marked success, among the most prominent being the Hammermill Paper Company, and the Rochester Gas and Electric Corporation, both of which operate boilers at 700 lb per sq in. with 50 and 100 per cent make-up, respectively. In both instances, the water is first softened in a cold-process softener using lime and soda ash and ferrous-sulphate treatment and, after settling, is delivered to a deaerating hot-process softener where it is treated with sodium phosphate, as illustrated in Fig. 6. This method is extremely effective in reducing hardness, and, in many samples, the calcium and magnesium are so much reduced that it is difficult to find them by laboratory procedure. Completeness of removal may be inferred from samples of filtered make-up water and of concentrated boiler water taken from the Hammermill Paper Company's plant. In spite of the many concentrations, both samples are equally clear.

Since chemical reactions always proceed more rapidly at higher temperatures, the possibility of deposits in feed lines, stage heaters, economizers, and similar apparatus must always

[1] "Operating Experiences in a Sugar-Refinery Steam Plant," by Daniel Gutleben, MECHANICAL ENGINEERING, October, 1936, pp. 577–584.

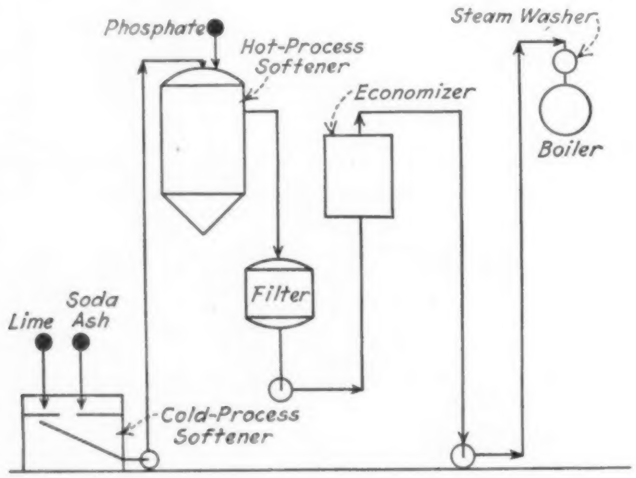


FIG. 6 SYSTEM OF FEEDWATER TREATMENT FOR PREPARING 100 PER CENT MAKE-UP

(This system is used in connection with 800-lb boilers by the Rochester Gas and Electric Corporation.)

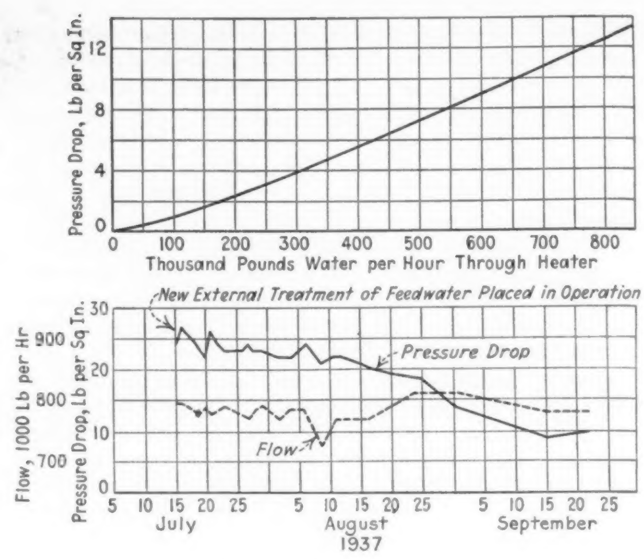


FIG. 7 PRESSURE-DROP CURVE FROM A STAGE HEATER IN A HIGH-PRESSURE PLANT

be considered. The phosphate-softening process, when properly controlled, effectively eliminates deposits and has demonstrated its efficiency by actually removing previously accumulated deposits. Illustrating this fact, Fig. 7 shows the drop in pressure at a comparatively constant rate of flow through a stage heater in a high-pressure plant. The drop decreased from 25 to 9 lb per sq in., which can be accounted for only by a gradual removal of deposits previously accumulated in the heater during the time when the water was not treated externally of the boilers. To carry out the two-stage method of softening, a phosphate-treating compartment can be installed as an integral part of the main sedimentation tank. This compartment need not be large, as the reaction occurs quickly and complete sedimentation is not generally necessary, as the quantity of precipitate formed can easily be handled by the filters.

For waters that are low in sulphates and relatively high in carbonates, it may be advisable to recirculate a portion of the concentrated boiler water, reducing the quantity of chemicals that need be added. By recirculating the concentrated boiler water, we can maintain a higher concentration of treating chemicals in the sedimentation tank without necessarily increasing the concentration of these chemicals in the boiler as would be required with the conventional method of operation. This reduces the quantity of treating agents and, therefore, the sodium sulphate required to satisfy the embrittlement ratio.

A two-stage softening system taking recirculation into account is illustrated by Fig. 8, in which the blowdown water is divided, part going to waste through a heat exchanger and part being delivered to the hot-process softener after being measured by a flowmeter for ease of adjustment. Calculations as to chemical costs indicate invariably that this method of operation is economical. On the other hand, we must not lose sight of the fact that recirculating concentrated boiler water increases the over-all cost of operation by (*a*) degradation of heat and (*b*) increased pumping charges. The heat from the boiler is recovered at a low temperature level, suffering the same handicap of degradation as in an evaporator.

The two-stage softener shown in Fig. 9 is in operation at Naples, Italy, preparing feedwater for 900-lb pressure boilers. In this instance, lime-and-soda-ash and phosphate treatments are carried out separately in individual tanks of the same dimen-

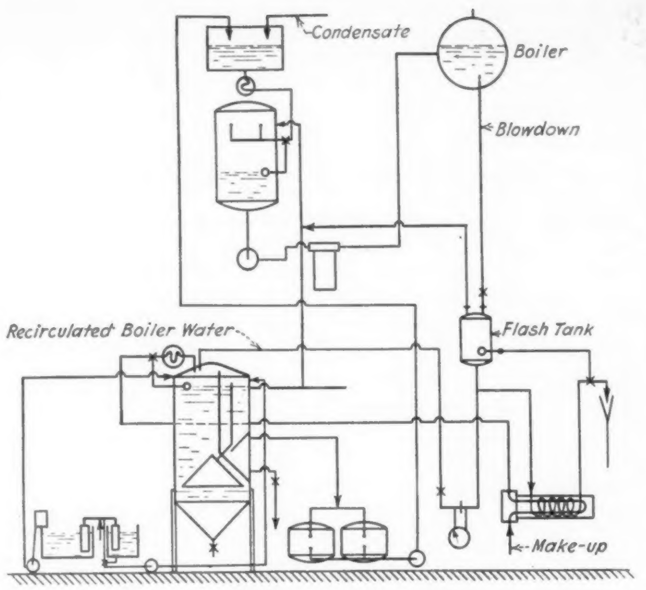


FIG. 8 TWO-STAGE SOFTENING WITH RECIRCULATION OF CONCENTRATED BOILER WATER

sions, and oxygen is eliminated from the water in an independent deaerating heater. Importance of removing silica has been mentioned and, with soft waters where the lime-and-soda treatment is not applicable, it may be desirable to remove silica separately, as the first stage of the conditioning process. Ferric sulphate has been used effectively for this service, and, in one water supply containing approximately 12 ppm, the silica has been reduced to 4 ppm. It is precipitated by ferric sulphate in a continuously operated sedimentation tank, similar to that of a cold-process softener. Settled water is filtered through anthracite and then delivered to a deaerating hot-process water softener, where it is treated with sodium phosphate, which reduces the calcium to low limits. The general arrangement of the equipment is shown in Fig. 10.

The precipitation type of water softener, using the hot process, meets the requirements of modern high-pressure boilers with almost any kind of water supply. Modified and improved treatments available with this type of softener reduce hardness to lower limits than do any other known methods of water softening. This type of softener and process modified to suit the water conditions can be used for the highest steam pressures. It is interesting to note the differences between the lime-soda and supplementary-phosphate softening and softening by phosphate. The reduction in hardness that is obtained eliminates the accumulation of sludge in the boiler water.

ZEOLITE SOFTENING

Although the zeolite process has been in use and its chemical theory generally known for years, it may be well to define clearly the differences between exchange softening and precipitation softening, as in the lime-and-soda process, for example. Results are different only in the treatment of carbonates; thus, in the lime-and-soda process, addition of lime precipitates the carbonates to the limit of solubility, while in zeolite softening, the sodium is exchanged for calcium and the softened water carries sodium bicarbonate chemically equivalent to its original content of calcium and magnesium bicarbonate, the respective reactions being

$$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 + 2H_2O \quad [1]$$

$$Ca(HCO_3)_2 + Na_2Z \longrightarrow 2NaHCO_3 + CaZ \quad [2]$$

The zeolite method of softening is satisfactory without modification for waters low in hardness and carbonates, as it would produce a soft water having a hardness in the neighborhood of 5 ppm but low in alkalinity and total solids, and the cost of treatment would probably be lower than that of any other method. However, in many cases, pretreatment with lime or aftertreatment with acid must be used to correct the uncontrolled alkalinity, decidedly limiting the proper field of zeolite softeners.

A lime-zeolite plant in which lime, in some cases supplemented by coagulant, is used to precipitate the carbonates in accord with reaction [1], shown in Fig. 11. The partially softened water is then passed through the zeolite softener, giving a water that is comparatively low in alkalinity and solids at low cost for treatment. Many such systems have been placed in operation and have given good results. Precipitation of carbonates by lime has a scouring action and removes other impurities, such as organic matter. This treatment is particularly well-suited to turbid waters, since if zeolite softening is to be applied, the water must first be clarified, which is best accomplished by simultaneously removing the hardness with lime.

Treatment of a high-carbonate well water with zeolite, after which sulphuric acid is used for reducing alkalinity, is illustrated in Fig. 12. The resulting content of solids in the treated water is high, in fact, higher than in the raw water initially, as nothing is precipitated, hardness merely being converted to the corresponding sodium salts, while the high carbonate content is reduced and converted to sodium sulphate. Another objectionable feature is the danger of acid reaching the boiler in the event of failure in proportioning to the feed. With

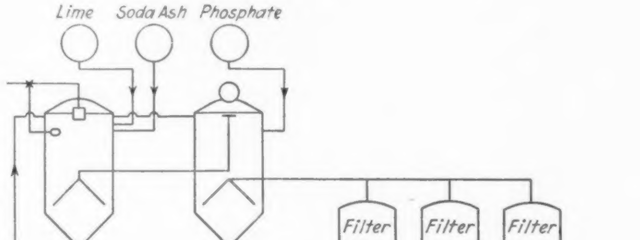


FIG. 9 FLOW DIAGRAM OF TWO-STAGE SOFTENING SYSTEM

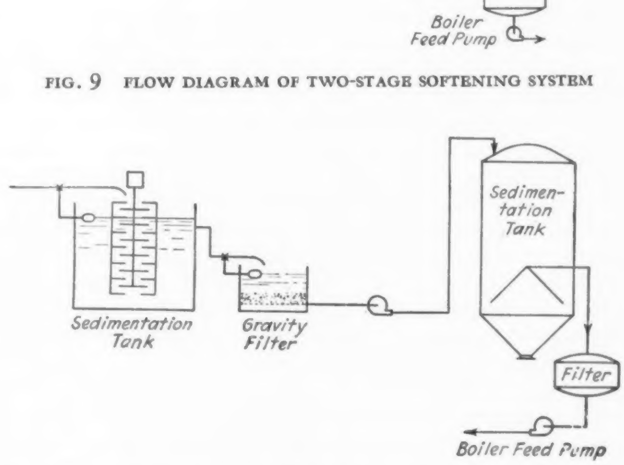


FIG. 10 TWO-STAGE SYSTEM FOR SILICA REMOVAL AND PHOSPHATE SOFTENING

either pretreatment by lime or aftertreatment by acid, treatment by phosphate or other supplementary treatment is necessary to prevent silicate scale. Generally speaking, zeolite treatment, with adjuncts where required, will reduce the hardness to as low as 5 ppm.

HYDROGEN ZEOLITES

For small plants, the zeolite softener has the inherent advantage that it is simple to operate, low in first cost ordinarily, and easy to install. The undesirability of uncontrolled alkalinity has been recognized for years, and zeolite materials that make controlling the alkalinity of the effluent possible have

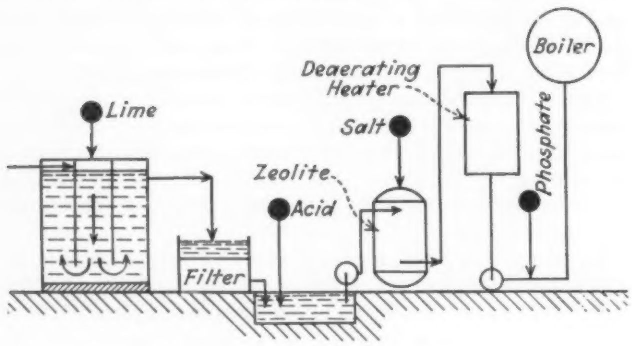


FIG. 11 LIME-ZEOLITE PLANT

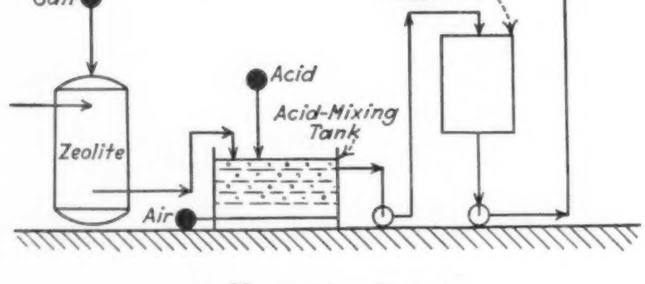


FIG. 12 ZEOLITE-ACID PLANT

now been developed. Zeolite minerals exchange one base for another. For example, if zeolite mineral is regenerated, as is customary, with sodium chloride or any sodium salt, such as the nitrate or sulphate, calcium is exchanged for sodium. If instead of regenerating the zeolite mineral with sodium salts, it is regenerated with iron salts, the exchange would be calcium for iron, while if acid, such as sulphuric acid, be used for regeneration, calcium and magnesium would be exchanged for hydrogen; and, subsequently, if water containing calcium sulphate be passed through the zeolite, the calcium sulphate will emerge as sulphuric acid, and, similarly, calcium chloride would be converted to hydrochloric acid. Ordinary mineral zeolites are, however, sensitive to even slightly acid or alkaline water and any procedure such as that just described would injure the mineral.

Recently, a synthetic zeolite has been produced in England. This is a polymerization product containing organic material or carbon compounds which withstands acid and can, therefore, be used to exchange hydrogen for the metals of salts in solution. The hydrogen-zeolite reactions are

Softening

$$Ca(HCO_3)_2 + H_2Z \longrightarrow CaZ + 2H_2CO_3 \qquad [3]$$

$$CaSO_4 + H_2Z \longrightarrow CaZ + H_2SO_4 \qquad [4]$$

$$CaCl_2 + H_2Z \longrightarrow CaZ + 2HCl \qquad [5]$$

Regeneration

$$CaZ + H_2SO_4 \longrightarrow H_2Z + CaSO_4 \qquad [6]$$

The hydrogen-zeolite reaction toward sodium bicarbonate is

$$2NaHCO_3 + H_2Z \longrightarrow Na_2Z + 2H_2CO_3 \qquad [7]$$

TABLE 1 COMPOSITION OF WATER BEFORE AND AFTER TREATMENT WITH HYDROGEN ZEOLITE

	Raw		Treated	
	Ppm	Eq pm	Ppm	Eq pm
pH value	7.70	...	3.90	...
OH	0.00	...	0.00	...
CO_3	0.00	...	0.00	...
HCO_3	154.30	2.53	0.00	0.00
Cl	1.00	0.03	0.50	0.01
Solid matter	1.00	...	1.00	...
Soap hardness	126.00	2.32	5.00	0.10
CO_2	2.20	0.10	53.00	2.50

As will be seen, calcium is replaced by sodium or by hydrogen, depending upon whether sodium chloride or sulphuric acid, respectively, has been used for regeneration of the zeolite. Table 1 shows the composition of a raw water and of the treated water resulting from this process. Important facts are that the soap hardness has been reduced from 126 to 5 ppm, and the carbon dioxide increased from 2.2 to 53 ppm by the transformation of calcium bicarbonate to carbonic acid; also, the chloride is converted to the corresponding quantity of hydrochloric acid, which in conjunction with the relatively high quantity of carbon dioxide has decreased the pH value from 7.7 to 3.9.

To render water softened by an acid zeolite suitable for feeding to boilers, the acid must be neutralized, either by adding caustic soda or by blending the acid water with water softened by the sodium-zeolite process. A plant in which caustic soda is used for neutralizing the acidity is shown in Fig. 13. The carbon dioxide is liberated from the water in the aerating tower down to approximately 10 ppm, after which the treated water is deaerated in an open heater, while phosphate and sodium

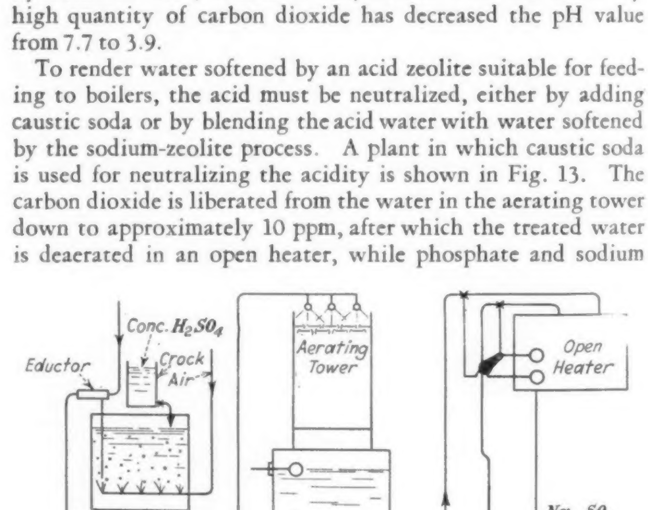


FIG. 13 HYDROGEN-ZEOLITE INSTALLATION

sulphite are added at the suction of the boiler feed pump. Using the cycle shown in Fig. 14, water softened by sodium zeolite is blended with water softened by hydrogen zeolite and the mixture aerated for removal of carbon dioxide and subsequently deaerated to release carbon dioxide not liberated in the aerating tower, together with oxygen. In this way, the carbonate content of high-carbonate waters can be reduced by the zeolite process to the same limits as by the lime-and-soda process, overcoming serious objection to zeolite softening. Hydrogen-zeolite softening is particularly well adapted for the reduction of the sodium carbonate found in some waters, as the carbonate is removed entirely, without any permanent byproduct. It is, in fact, the only method available for handling water supplies of this character and has here a definite application.

Most persons know zeolites as minerals that exchange one metal for another, such as magnesium and calcium for sodium, and the possibility of exchanging calcium for hydrogen has just been mentioned. This raises the question as to whether it would be possible to exchange acid radicals one for another. For example, could a product be made that would exchange sulphate for carbonate, sulphate for chloride, and so forth? Such products actually have been made in England and apparatus installed for experimental purposes. By passing the water through two zeolite units in series, the first to exchange its metals for hydrogen and the second to exchange the acid radicals for carbonate, the effluent from the second softener would contain carbonic acid or carbon dioxide in solution. The water would be soft and would need only to be aerated and subsequently deaerated and then given a suitable alkalinity for feeding to boilers. Application of this process to small high-pressure boiler plants may be expected in the near future if the experiments that are being conducted at present work out as anticipated.

Means available for conditioning water and the application of each method having been described, it will be obvious that a water having characteristics suiting it for feeding to boilers can be produced with a zeolite softener or by the hot process. Which should be selected will depend upon such factors as (*a*) cost of equipment and installation, (*b*) cost of operation, and (*c*) space that is available. Selection of the method then resolves itself into an analysis of the first costs and the costs of operation.

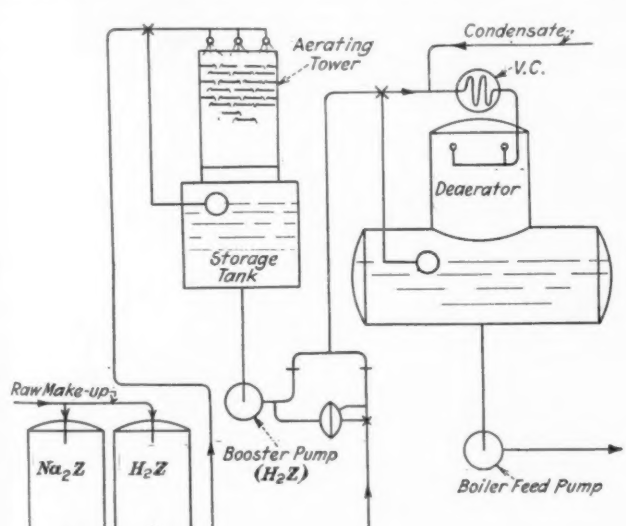


FIG. 14 FEEDWATER CYCLE FOR SODIUM AND HYDROGEN-ZEOLITE PROCESS

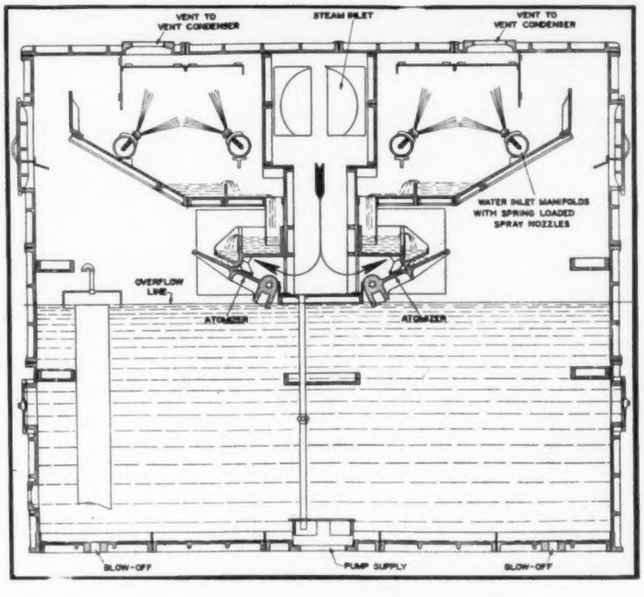


FIG. 15 ATOMIZING-TYPE DEAERATOR

Under conditions of present-day boiler operation, deaerating equipment is indispensable. It can be incorporated as a direct-contact heater forming an integral part in the sedimentation tank of a hot-process softener, but ordinary trays would not be satisfactory for this purpose as deposits of scale and sludge would soon make them ineffective. Water softened by ordinary zeolite with an aftertreatment of acid or by hydrogen zeolite is distinctly acid and high in carbon dioxide, which causes rapid destruction of trays. To overcome tray scaling and corrosion, a new method of deaeration has been developed wherein, instead of passing the water over trays, it is atomized by a high-velocity jet of steam like oil in an oil burner. A large independent deaerator of the atomizing type for zeolite-softened water after treatment with acid is shown in Fig. 15. Before this equipment was installed, corrosion of heater trays had been rapid, but it was entirely eliminated by use of the atomizing deaerator. In the operation of this apparatus, the water is first preheated by spraying through a steam atmosphere, after which it is finely subdivided by steam blasts, effectively releasing oxygen and carbon dioxide.

The efficiency of this method of deaeration is shown by the results in Table 2. In spite of initially high carbon dioxide and oxygen, the gases were reduced practically to zero in the effluent and, in addition, an appreciable conversion of bicarbonates to carbonates occurred, so that the release of carbon dioxide by mechanical atomization alone increased the pH value from approximately 5.7 to 8.7, the water leaving the heater being 1000 times more alkaline than the water which enters it. Effectiveness of this method of deaeration is ascribable to improved utilization of the physical principles and laws relative to diffusion through liquids and gases. The rate of transfer of gas dissolved in a liquid to a contiguous steam atmosphere varies directly as the difference between the concentration of the gas in the liquid and its concentration in the steam and also as the surface per unit volume, but inversely as the distance to be traversed; in other words, directly as concentration gradient and inversely as hydraulic mean depth. Transfer is, therefore, promoted by shortening the distance as by breaking the water up into small drops and by increasing the turbulence of both water and steam, since the gas dissolved in

the liquid is thereby brought up to the boundary surface, while concentration of gas on the steam side is avoided by rapidly sweeping it away.

TABLE 2 TYPICAL ANALYSES OF ATOMIZING-TYPE DEAERATOR PERFORMANCE UNDER ALL LOAD CONDITIONS WHEN ONLY HALF OF HEATER IS OPERATING

	Water to heater					Water leaving heater				
Water leaving heater, lb per hr	Oxygen, cu cm per l	Free carbon dioxide, ppm	Bicarbonate, ppm	Carbonate, ppm	pH value	Oxygen, cu cm per l	Free carbon dioxide, ppm	Bicarbonate ppm	Carbonate, ppm	pH value
156,000....	7.5	33	40	0	5.9	0.01[a]	0	26	6	8.7
204,000....	7.0	25	35	0	5.7	0.01[a]	0	21	6	8.7
255,000....	7.5	32	28	0	5.9	0.01[a]	0	18	4	8.7
305,000....	7.0	34	33	0	5.7	0.01[a]	0	29	6	8.6
375,000....	7.5	35	33	0	5.7	0.01[a]	0	29	6	8.7
474,000....	7.5	33	39	0	5.9	0.01[a]	0	35	2	8.7
510,000....	8.0	20	39	0	6.0	0.01[a]	0	35	2	8.6

[a] Less than 0.01.

Turbulence is also effective in diminishing the resistance to diffusion through liquid and gaseous boundary layers or films. Steam, being a light gas, cannot be projected far through water as small bubbles at high velocity, but the much heavier water droplets, given a high initial velocity, will penetrate a steam atmosphere over a long trajectory, and, as might be expected, spraying and atomization have proved to give much better deaeration than does bubbling and reboiling. In the atomizing deaerator shown in Fig. 15, final atomization is done by incoming steam, most of which remains uncondensed, since the water has already been heated practically to steam temperature by spraying. This uncondensed steam is then applied to heating the incoming, undeaerated water, except for a small fraction which is vented with the noncondensable gases. Deaerators of this type have been completely effective in numerous installations.

Gases other than oxygen and carbon dioxide may need to be removed from water, as for example ammonia, which is commonly used in city water supplies for the fixation of chlorine or may result from contamination by industries. Entering with the feedwater, ammonia is carried over with the steam and may accumulate in the condensers and cause disintegration and failure of the brass tubes. Special equipment which marks a decided departure from ordinary deaerator practice is now being installed by a central station in western Pennsylvania to remove ammonia that is present in the combined form and in quantities of less than 2 ppm.

To sum up, development of methods and equipment to condition feedwater properly has anticipated the operation of generators at high-temperature ranges, i.e., up to 1800 lb per sq in. Availability of the several methods for treating water that have been briefly outlined and their suitability to given supplies require intimate and accurate knowledge of the merits of each method for proper selection in each generating plant. The brief review presented defines objectives and suggests the chemical and mechanical factors that should receive consideration as the chemists and engineers continue advancement in the methods of treating feedwaters.

Charles Phelps Cushing

LOGS FOR THE LUMBER MILLS AT LONGVIEW, WASH.

TEMPERATURES *in* DRYING

Their Effect on Cost of Operation and Wear Resistance of Textiles

By B. R. ANDREWS

ANDREWS AND GOODRICH, INC., BOSTON, MASS.

THE MANUFACTURE of finished textile products is probably one of the oldest industries. In all the years since this industry has come indoors, drying between different operations in the production of fabrics has constituted a process vitally affecting quality. Because of its recurrence many times in the steps from raw stock to finished article, drying is a large item of cost. Yet progress, to date, in learning to dry the maximum quantity of first-quality goods at minimum expense seems altogether too small for the amount of attention that has been given to it by makers of cloth and manufacturers of equipment for its drying. Engineering aspects of drying where latent heat of vaporization is supplied by a gaseous medium are exceedingly complicated with an unusually large number of variables. Perhaps an attempt to view too many factors at once has retarded a more complete study of each individual factor or variable. This paper, therefore, is intended to deal only with temperature in drying with air or superheated water vapor.

Drier temperature affects character and quality of the fiber whether it be in raw stock, sliver, top, yarn, warp, or any of the various finishing operations. It affects the color, handle, and wearing quality. Whites can be yellowed by it; dyed goods can be shaded. Surface feel can be made harsh or soft. Handle can be changed in drying so that drape and ability to be creased or to retain such creases are altered enough to be recognized by the ultimate consumer. All of these effects take place at temperatures that vary with method of application of heat and relative quantity of moisture remaining in any of the fibers when they leave the drier, as well as the length of time the goods retain the heat absorbed.

COST OF DRYING AFFECTED BY TEMPERATURE

Temperature in drying affects the cost of the operation, because required heat input, power to move the drying medium, and output of any given drier are all involved with the temperature used. Heat input to a drier supplies radiation and leakage losses from its exterior, heat in the exhausted vapor and drying medium, latent heat of evaporation of water from the material being dried, and increased sensible heat of that material.

Radiation losses can be cut to small values without making an expenditure for insulation that fails as a good investment. Leakage losses can be almost entirely eliminated if the housing is well-built. Loss out of the exhaust fan is more involved. This is the item that is most affected by the drying temperature and the factor that determines the thermal efficiency of the drying machine in cases where the foregoing losses have been properly reduced.

The exhaust carries away the water vapor. Consequently, where air is the drying medium, the volume of exhaust is greatest when its water content is low and smallest when the water content is high. However, the capacity of the drier is highest when relative humidity is low, and lowest when the relative humidity is high. Therefore, high drier and consequent high exhaust temperatures give both high drier capacity and lower relative humidity in the exhaust, with a relatively small exhaust volume but a high total heat per cubic foot. If, however, superheated water vapor is the drying medium, it is always received by the drier from the water vaporized out of the material being dried at the temperature of vaporization, and the volume of the exhaust is only that of the water vapor evaporated from the product of the drier.

OPERATION AT HIGH TEMPERATURE MORE ECONOMICAL

To apply the foregoing to an actual case so that the rather vague terms "high" and "low" can be more accurately determined, five imaginary driers are analyzed in Table 1. They are presumed to have like methods for disposing of the material in them and applying the drying medium and to be capable of fast drying. Each receives the same goods with equal wetness and delivers them with equal regain.

TABLE 1 ANALYSIS OF FIVE DRIERS

Drier no.	1	2	3	4	5
Drying medium	Air	Air	Air	Air	Superheated water vapor
Exhaust temperature, F	180	180	180	280	280
Relative humidity of exhaust, per cent	5	15	35	5	...
Drier lengths, ft	200	258	430	100	100
Steam per pound of water evaporated, lb[a]	4.50	1.98	1.63	1.70	1.25
Power required to circulate drying medium, hp	60	75	130	30	30
Steam and power cost per 1000 lb of water evaporated	\$3.00	\$1.93	\$2.45	\$1.23	\$0.99

[a] Exclusive of sensible heat added to material.

The first three have an exhaust temperature of 180 F and operate with relative humidities of 5, 15, and 35 per cent, respectively; the other two have an exhaust temperature of 280 F. No. 4 uses air and exhausts with 5 per cent of vapor and No. 5 uses superheated water vapor only. Their size is adjusted so that each evaporates 1000 lb of water per hour. Power is charged at 1.25 cents per hp-hr and steam at 50 cents per 1000 lb. These figures are theoretical calculations based on well-established data, and, because no allowance has been made for leakage, they indicate a cost which is slightly below possible commercial practice, yet they do parallel actual field results closely.

Circumstances may compel adoption of any one of the five combinations at times, but those operating with higher temperature are more economical to use and occupy the least floor space. Furthermore, while new plants are built from time to time and radical rearrangements of machinery are sometimes made, it is usually desirable, if not actually necessary, to make provision for increased production or reduced operating costs in floor space already allocated in existing machinery layouts.

Presented at a meeting of the Textile Division, Boston, Mass., Oct. 15, 1937, of The American Society of Mechanical Engineers.

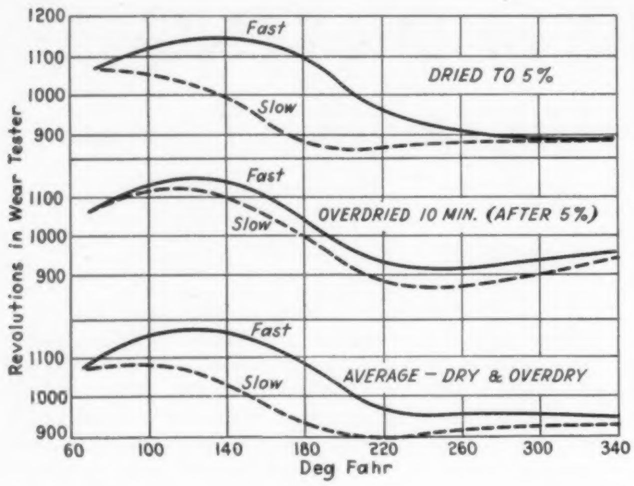


FIG. 1 INFLUENCE OF RATE OF DRYING UPON WEAR RESISTANCE

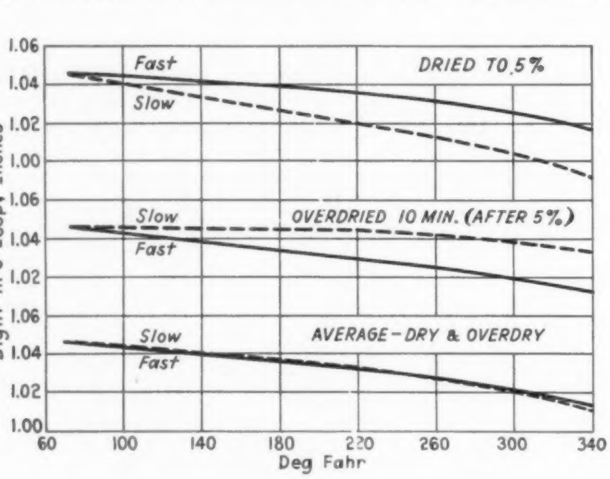


FIG. 2 RESISTANCE TO BENDING OF GABARDINE SAMPLES

Such arrangements of equipment generally have also determined the number of operatives to each drier or range in which the drier is a part. Therefore, if a plant can increase the capacity of its drying units without enlarging them and at the same time reduce operating cost per unit of production, the total saving in the cost of manufacturing an article requiring four or five separate dryings is large.

STUDY OF DRYING TEMPERATURES NOW BEING MADE

A realization of this condition has manifested itself in the work now being undertaken by the U. S. Institute for Textile Research in a study of temperatures in drying. This should, in time, greatly augment the meager fund of information now available as to just how high a temperature can be used in a properly designed drier without detriment to the quality of the product dried. However, it will take years to get test information of this sort into usable form so that its findings can be applied to manufacturing operations. In the meantime, progress toward better drying can be materially hastened by a more general acquaintance with the accumulated knowledge of the effect of velocity and direction of application of the drying medium, the importance of the point at which the drying operation is discontinued, and the care of goods immediately after drying.

To produce goods that are suitable, all plants have been obliged to give much time and study to the effect of driers on their product. Drawing definite general conclusions from the results of their experience is difficult because of the many variable quantities previously mentioned and because few plants measure drier temperatures in the same way. Thermometers are frequently located where they are convenient to read rather than where they will indicate the temperature at the material. However, by taking temperatures at the material in a great many driers over a long period of years, it can be stated with some degree of accuracy that the maximum temperatures at the cloth given in Table 2 are in use by plants

TABLE 2 MAXIMUM TEMPERATURES AT THE CLOTH USED BY DRYING PLANTS, DEG FAHR

	Adequate circulation	Inadequate circulation
Cotton stock	270	240
Wool	250	160
Cotton piece goods	320	260
Worsted piece goods	250	180

making high-grade goods and using no greater heat than they feel is consistent with quality. While these temperatures indicate an approximate cross section of today's practice, it should be borne in mind that higher temperatures are already being used.

Furthermore, when more accurate methods of reading the moisture content of delivered goods are available with dependable means of translating these continuous readings into drier speed, still higher temperatures can be used in these same

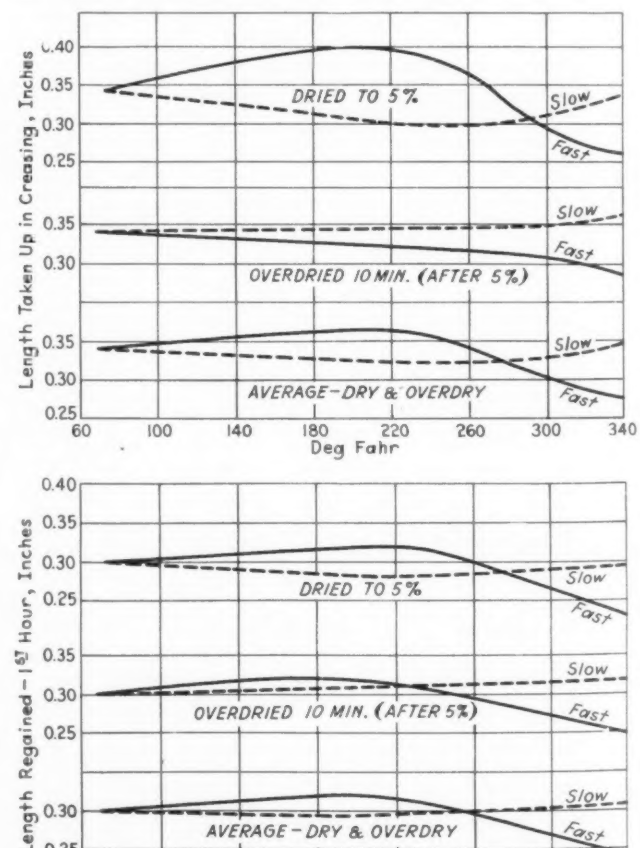


FIG. 3 RESULTS OF CREASING TESTS

(Upper chart shows influence of rate of drying upon length taken up in creasing; lower chart shows the ability to recover original shape.)

driers because overdrying, which is now unavoidable, will be eliminated.

FAST-DRIED GOODS HAVE GREATER WEAR RESISTANCE

Results of many years of work with textile driers and drying indicate clearly that economies of drying at higher temperatures are possible for many more textiles and textile plants than now enjoy them. In some cases, these savings can be made on existing driers, although in general, the existing method of applying the drying medium requires revision to protect the fibers and the quality. Tests made by Sampson, Gautreau, & Rolland in the laboratory of Andrews & Goodrich, Inc., on fabrics, the fibers of which had never been subjected to a temperature higher than 160 F, seem to emphasize the foregoing statement, and the following description, with analysis of one group of these tests, is given to indicate where the field of better drying seems to lie. Samples of white and dyed worsted gabardine were dried fast from 100 per cent wetness to 5 per cent at varying temperatures from 140 to 340 F with rapid, efficient air circulation. Another set was similarly dried except that it was left in the drier for 10 min after the 5 per cent point had been reached. Others were treated in the same way but slowly dried, with less rapid air circulation that was not so well applied.

These samples were tested for wear on a combination machine giving in sequence four smooth abrasions, one light blow from a hammer, and one light abrasion with emery paper,

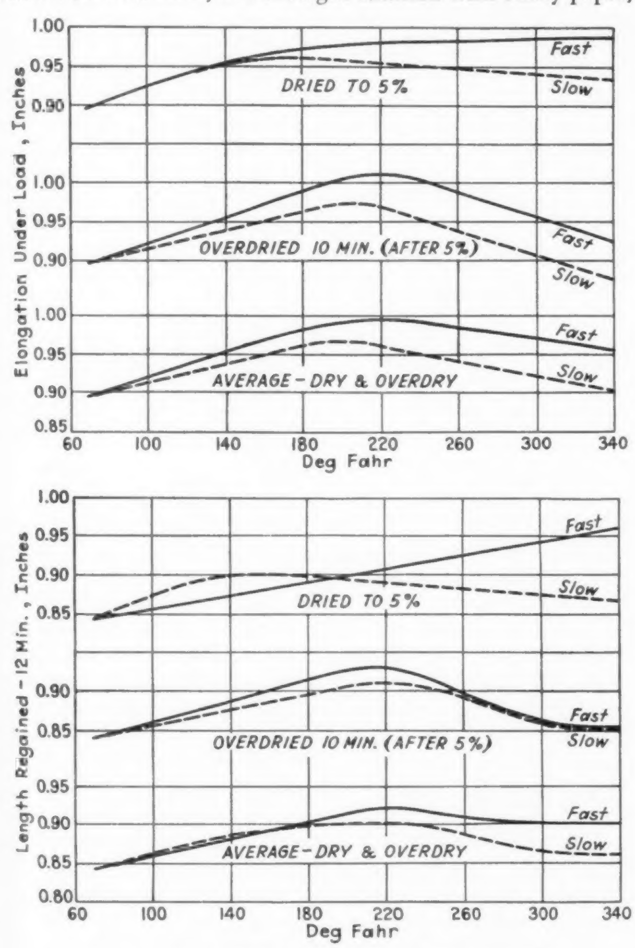


FIG. 4 ELONGATION UNDER LOAD AND RECOVERY

(After the samples had been subjected to similar loads for 12 min, they showed the results given in the upper chart. The lower chart shows the recovery of the samples in 12 min after removal of the load.)

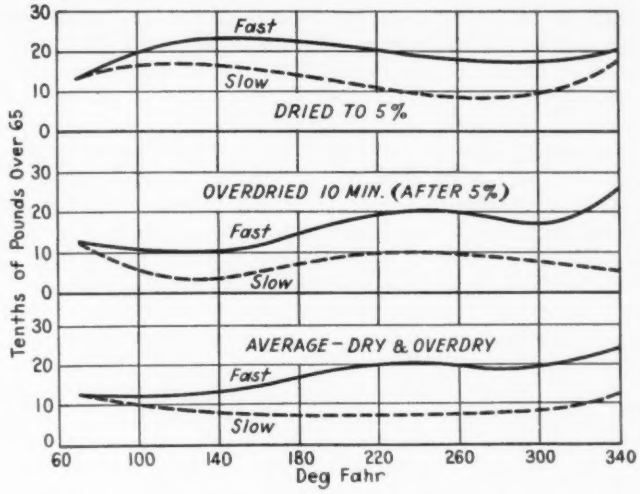


FIG. 5 EFFECT OF DRYING RATE ON TENSILE STRENGTH

all under constant humidity and after like rest periods between drying and wear. Results of this test are illustrated in Fig. 1.

Test pieces, after pressing, were each held together at their ends and accurate measurements made across the bight thus formed, to test for stiffness. Fig. 2 gives the results of this test. Again they were tested for ability to be creased and to recover their original shape, by measuring the change in the length of strips given nine creases. All samples were hung for the same time under the same condition of humidity and temperature before measurement. The results of these two tests are presented in Fig. 3.

Lastly, each sample was tested for elasticity by measuring its elongation under like tension per inch of width and for recovery by taking the time required for the piece to readjust its length. Fig. 4 shows the results of these elongation tests.

To avoid confusion, tests of chemical changes or tensile strength, regain, and the like are omitted, and consideration is given only to those measurable properties that enter into judgment of feel, handle, and appearance under the eye and use in the finished garment. However, as a matter of interest, the effect on tensile strength is given in Fig. 5.

From the results of those tests where the drying operation was stopped when the water in the cloth equaled 5 per cent of its dry weight, it can be stated that ability to resist this type of wear-testing machine decreases steadily from the use of drier temperatures of 140 to 180 F in the case of slow drying. Fast drying, however, actually increases resistance to wear at temperatures below 180 to 185 F and permits use of 70 to 80 deg higher temperatures than slow drying for like wear properties. Higher drying temperatures beyond these points make little or no change in the number of revolutions of the wear tester required to break the samples.

Recoverable elongation per unit of tension is greater for fast-dried and less for slow-dried goods for each succeeding temperature from 140 F up, but the rate of recovery for such stretching, expressed in percentage of its elongation, is not appreciably affected by the temperature at which the cloth is dried unless temperatures above 200 F are used. Resistance to bending is also greater for fast-dried goods than for slow, and in each case is less for each succeeding temperature above 140 F. From 140 to 300 F, fast-dried goods take sharper pressed creases and hold them longer than those dried slowly.

If, however, the goods are overdried, little difference is

found in ability to resist the wear-testing machine whether this drying is fast or slow. The curve goes down from 140 F until it flattens out at about 220 F. Recoverable elongation, while again slightly in favor of fast drying, increases from 140 F to about 220 F and decreases from that point to 340 F. Recovery from stretching is a little faster in slowly dried fabrics but does not vary much with the temperature at which they are dried. From the foregoing, fast drying at temperatures under 280 F appears to cause high-count worsted gabardines made from fine wool to stand up in the wear-testing machine longer, stretch easier, resist bending more, take pressing better, and hold it longer than slow drying, provided they are not seriously overdried. Furthermore, the same statement is true for fast drying at 240 F as against slow drying at 180 F.

Results of all of these tests are confirmed by the operation of production driers in finishing plants where contact with heated surfaces, if made at all, is intermittent and brief and the time to reach a condition of 5 per cent water content from well-extracted goods is no longer than 2 to 3 min for loose cotton or wool and worsted piece goods and from 10 to 30 sec for cotton piece goods. Analysis of the foregoing data indicates that for worsted cloth driers

(1) Higher temperatures improve drier economy.

(2) Higher temperatures are permissible for like quality if drying is faster.

(3) At any temperature, fast drying improves quality.

(4) Maximum temperature limits for like quality vary inversely with the drying time.

Industrial Unionism in Action

(*Continued from page 222*)

fused to grant an industrial charter to the automobile workers and, a few days later, the Committee for Industrial Organization was formed by the United Mine Workers, the Amalgamated Clothing Workers, the International Ladies Garment Workers, and five other industrial unions, with John L. Lewis at its head. At that time the C.I.O. considered itself a committee within the A.F.ofL. It was the executive council of the A.F.ofL. which interpreted it as a dual movement and suspended the unions joining the C.I.O. Up to the present time, however, these unions have not actually been expelled from the A.F.ofL.[2]

C.I.O. CAMPAIGNS IN STEEL AND AUTOMOBILE INDUSTRIES

C.I.O. has gone forward from that time organizing, bargaining, and signing contracts, essentially as a separate organization, although there have been sporadic attempts by both sides to arrive at some kind of mutual agreement. The accomplishment in two years has been prodigious. A membership about equal to that of the A.F.ofL. has been built up and hundreds of contracts have been signed with industries where none existed before. These things alone justify the stand taken by the C.I.O. against traditional A.F.ofL. policies. If these millions of unorganized workers had not been more than ripe for organization such accomplishment in so short a time would not have been possible.

[2] [On Feb. 7, 1938, it was announced that the executive committee of the American Federation of Labor had revoked the charters of the United Mine Workers of America, the International Union of Mine, Mill, and Smelter Workers, and the Federation of Flat Glass Workers. Action against the seven other suspended C.I.O. unions was deferred until the April council meeting.—EDITOR.]

Mr. Walsh gives interesting descriptions of the C.I.O. campaigns in the steel and automobile industries and analyzes the tactics developed and used by both sides. He shows clearly the overwhelming importance of public opinion in determining the result when a strike is called to enforce demands. His statement of labor's attitude toward the sit-down strike, and his rebuttal of the arguments in favor of legislation to increase the responsibility of labor unions for their actions, are handled with skill and a real knowledge of the situation.

Whether we like it or not the C.I.O. is a fact, a live and powerful organization, whose significance cannot be overlooked in future developments. But there is justification for questioning Mr. Walsh's predictions for its political and economic future. He sees the likelihood that our present political parties will disappear and that new Conservative and Liberal parties will emerge, with the C.I.O. as the spear head of the Liberal party. This may be a possibility; but many questions in the labor situation must be decided before it could come about. How long will organized labor permit its house to remain divided? If the A.F.ofL. and the C.I.O. should again be united, may it not well be that the older organization will dominate, while adopting important policies from the newer one? Has the C.I.O. the power, especially in case of a prolonged depression, to hold on to its huge membership of unskilled workers, and pacify conflicting interests within its own unions? Will the C.I.O. get the necessary political support of the powerful farm group?

These and many other questions remain for solution in the future; but few will question the urgent need, so strongly emphasized by Mr. Walsh's book, for industrial leaders to revise some of their methods of dealing with labor, and to develop, in cooperation with their workers, new and more understanding industrial relations policies.

Observations on Economics, Politics, and Government

(*Continued from page 204*)

active in one party or the other. If you don't like the policies of a party in power, then I say, either join that party and help change its policies and leaders or join the party of opposition and check the politicians in power or throw the rascals out!

Only in this way can Americans erect a sure and safe defense against too high an integration of our government, against the overreaching governmental control which would deaden our initiative and creative enterprise, crush us with taxes, and rob us of our liberties. Finally, we Americans are not ready yet to concede that we must endure in our government a permanently high degree of economic control. We deserve a scheme of government in this country that will maintain for us our traditional individual liberty. We do not want the government or anybody else continually "snapping us into it." Even if a highly integrated American government could guarantee us a higher standard of living, the vast majority of Americans would prefer to risk a somewhat lower standard of living and have a great deal more liberty to live their own private economic lives. There are still millions of Americans, and I am sure you and I belong to this group, who would like to have the privilege, at odd moments and when in the mood, of lying lazily under a shade tree and gazing dreamily at the sky.

Problems of
SCIENTIFIC MANAGEMENT *in* UNIONIZED PLANTS

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PERHAPS I had best begin by suggesting that the term "scientific management" is somewhat of a misnomer. Management is not a science but rather an art which should be considered comparable to the arts of medicine, law, engineering, and the like. I am hopeful that management will someday achieve the professional status of these other arts.

For the purposes of this paper, therefore, let us consider scientific management as a rational approach to the problem of organizing, operating, and controlling the materials, buildings, equipment, tools, processes, funds, and human beings comprising a given institution, with a view to achieving its purposes as efficiently and humanely as possible. Problems of scientific management may be classified as follows: (*a*) policies; (*b*) organization; (*c*) personnel, the individuals who comprise the organization; (*d*) facilities and equipment; and (*e*) methods and processes. This classification applies to each of the following functional activities: (*a*) marketing, (*b*) production, (*c*) purchasing, (*d*) personnel and industrial relations, (*e*) finance, and (*f*) control.

Some specific problems of scientific management that are of especial importance in connection with organized labor include:

1 Introduction of new machinery
2 Improvement of plant methods and processes
3 Establishing wage and hour standards
4 Establishing work standards
5 Selection, transfer, promotion, layoff, discharge, and re-employment
6 Training of apprentices
7 Shop discipline
8 Stabilization of employment
9 Improvement of physical working conditions.

These nine problems are apparently the ones with which the executives of unionized plants are or will be most concerned. They relate primarily to the policies, facilities, and methods of production and industrial relations.

CAUSE AND NATURE OF PRESENT PROBLEMS

Considerable feeling exists among organized labor that the development of scientific management has tended to decrease the number of skilled as compared to unskilled jobs. Obtaining reliable information in this connection is difficult, however. Opinions among factory executives and engineers relative to this trend differ, mainly because of the difficulty of defining skilled and unskilled jobs. One prominent industrial engineer opines that the tendency of scientific management is to squeeze the unskilled elements out of so-called skilled jobs. This means that production operations include fewer skilled jobs. On the other hand, although the ratio of skilled to unskilled jobs has decreased in production, skilled repair and maintenance jobs have increased.

Technological aspects of scientific management, including its standardization and its specialization of human effort, seemingly have tended to make the worker increasingly dependent upon the skills, attitude, and integrity of management for his capacity to earn a living. The specialization that follows upon the detailed division of labor does create problems of coordination more difficult than those found under the older type of management. Coordination of specialists is one of the most difficult problems facing management today. If, in all levels of the organization structure, management is efficient in solving this problem, the entire organization is a more effective working unit. On the other hand, if, because of defects in management, the problem is not solved successfully, a so-called scientific-management plant may be far less successful and comfortable to work in than a traditionally managed plant.

The increased dependence of the worker upon management, including technical specialists, in some cases far removed from his work, and industrial relations men has, in the opinion of many students of management, tended to increase the worker's need for representation through unions. Opinions expressed in this connection, however, are far from unanimous. British experience has indicated that this is a moral need which is comparable to that of a nation for democratic government. In this country, the tendency of management, with a few notable exceptions, to make changes affecting the worker without explaining matters patiently and fully to him in advance, through employee representation or other means, has undoubtedly caused the worker to feel the need of union organization to represent him in arguments concerning his job.

The feeling of industrial workers for the need of representation through union organization has been relieved to some extent during the last two decades by functionalized personnel management. This has been especially true in the small percentage of companies with efficiently organized and operated personnel departments. Functionalized personnel management, however, has been limited largely to the proper discharge by management of one of its responsibilities. It has been limited also in most cases to the individual company and not extended to the industry as a whole as a means of bringing the less enlightened employers into line with proper industrial-relations standards. The progressive company that has developed a sound program, therefore, has often been the victim of bad personnel management in competing companies. This failure of functionalized personnel management to extend itself

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on an industry-wide basis has, to some extent, increased the workers' desires for union representation. Unfortunately, however, union organizers have all too often first approached employees of companies with good industrial relations instead of concentrating on companies where conditions were bad.

Scientific management has tended to eliminate traditional lines between various trades and, perhaps in some cases, to destroy established trades. Elimination of traditional boundaries would seem to be true, however, in most occupational pursuits. Failure of some craft unions to adjust themselves to this trend has favored the C.I.O. type of union in many industries, notably mass production. However, the organization of industry itself may have put a premium on industrial unions.

Considerable feeling exists that specialization and standardization of work have deprived many jobs of their educational value. Most semiskilled and unskilled jobs require only short periods of training. Also, the development of better techniques of industrial training has tended to decrease the length of apprenticeship required for many skilled jobs. Technological progress in this country has increased the need for technical specialists and for greater managerial skills in the lower as well as upper levels of supervision, which has made it harder for workmen to rise through promotion. This difficulty of rising from the ranks may be due also in part to the development of American educational institutions in the last twenty or thirty years and to the decrease in the percentage of outstanding men who leave school before completing college or at least high school. In other words, to find promotional material in the lower brackets is increasingly difficult. These circumstances have tended to some extent to increase class consciousness and the effort to secure benefits through union organization and politics.

Introduction of labor-saving equipment has, apparently, caused problems of technological unemployment. These, however, were not as acute in the 1920's because workers who had been displaced often found other jobs quickly in the company or outside. Also the reduction in costs and prices that accompanied the introduction of labor-saving equipment frequently resulted in increased sales and production and in no decrease in employment. Cyclical unemployment caused by the depression focused undue attention on problems of technological unemployment. This was further aggravated by lack of adequate dismissal-compensation plans or unemployment benefits. Considerable difference of opinion, however, can be found relative to technological unemployment. Studies of the Brookings Institution suggest that lower costs due to technological change will broaden markets and increase employment. On the other hand, the question has been raised as to whether adjustment of displaced workers can keep pace with technological developments.

OBJECTIVES AND METHODS OF ORGANIZED LABOR

The foregoing trends have contributed to the present attitudes and activities of organized labor. In general, objectives of the labor unions that seek business relationships with employers include continuous improvement in standards of living, wages, hours, and working conditions and in security against injury, disease, old age, and unemployment. These unions want the employees to share proportionately with employers and society in the benefits due to technological improvements. This means that unions want more control of the job. More specifically, labor unions want:

1 Standard wage rates for each classification of jobs; nature of the industry, however, will usually determine whether time or piece rates are favored.

2 Higher real wages; organized labor wants "more" which, however, is typical of most Americans.

3 Proper differentials in wage rates that will recognize different degrees of skills, training, hazards, and the like.

4 Extra pay for overtime, nightwork, and work on Saturdays, Sundays, and holidays.

5 Shorter hours, whose objectives include increasing wage rates and providing more employment. The latter is based, however, on faulty economic theory, which will be discussed later.

6 Greater control of technological changes, labor desiring to restrict the breakdown of skilled jobs into semiskilled and to prevent technological employment.

7 Safe and sanitary working conditions.

8 Security and continuity of employment, including (*a*) control of hirings and separations, (*b*) seniority as a basis for promotion, layoff, and reemployment, and (*c*) some control of disciplinary measures.

In their attempt to achieve these objectives, labor unions have included in their methods the following tactics:

1 Collective bargaining, aiming at trade agreements.

2 Strikes, boycotts, picketing, and court action.

3 Adoption of the policy that there is only just so much work to be done, which had led to (*a*) closed-shop policy, (*b*) limitation on memberships in unions, (*c*) limitation of apprentices, (*d*) restriction of output, (*e*) obstruction to introduction of new machinery, (*f*) obstruction to improvements in processes, and (*g*) obstruction to certain other activities of scientific management, including time study, motion study, wage incentives, and various aspects of personnel management.

4 Union-management cooperation.

Although the history of scientific management is replete with examples of the labor unions' obstructionist tactics, some noteworthy exceptions can be found. Beginning about 1925, the trend on the part of union leaders has been in the direction of cooperating with managment in improving industrial efficiency. Such labor leaders as William Green (1),[1] Sidney Hillman (2), and Matthew Woll (3) have gone on record favoring union-management cooperation. Union-management cooperation has been practiced since 1923 on the Baltimore & Ohio Railroad and later on other railroads (4). The Amalgamated Clothing Workers of America have for many years cooperated with management in developing efficient methods of work (5). Several years ago, a significant experiment in union-management cooperation was undertaken by the Naumkeag Steam Cotton Company at Salem, Mass. (6). In such cases, however, labor has wanted to share in the gains from improved methods and equipment.

Much opposition, nevertheless, still persists to the advances of scientific management. Some of this is indicated in the daily news. In the last few years, we have read much about objections to the "stretch-out" in the textile industry and the "speed-up" in the automobile industry. More recently, we have read of labor agitation against the proposed visit to this country of the Duke and Duchess of Windsor, because this visit was to be sponsored by an efficiency engineer who had installed many wage-incentive plans.

Problems of scientific management in organized plants will become more and more important in the next decade. Although it is difficult to predict the extent of labor organization that will be effected in this country, many students claim that collective bargaining is inevitable in a democratic society. If this be true, I am hopeful that it can be developed into collec-

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

tive cooperation and that, to quote Lloyd Roberts, chief labor officer of Imperial Chemical Industries, Ltd. (7), we will "identify ourselves with the inevitable." If collective bargaining be inevitable, we should take the lead in developing collective cooperation and not surrender our leadership to outsiders. The remainder of this paper will discuss the steps to be taken in developing collective cooperation with employees' representatives, either independent of or affiliated with national unions, in plants that have been unionized and where no dispute over recognition exists.

PERSONNEL POLICIES AND MANAGEMENT ORGANIZATION

The first step in developing a program of collective cooperation is the establishment of definite industrial-relations policies. These should be developed by the senior executives of a given company meeting in conference with the president, and the tentative policies that are developed should be discussed at length with the supervisory forces at conferences. The tentative policies should then be discussed with the employees' representatives and, by group thinking, final industrial-relations policies should be established covering such matters as collective bargaining, grievances, wages, hours, overtime, vacations with pay, dismissal compensation, disability and death benefits, pensions, employment, seniority, training, health, safety, and the like. Some of these policies may logically be embodied in a formal agreement with the union, but it would seem desirable to keep this agreement as simple as possible. In any event, a definite statement of industrial-relations policies should be published for the information and guidance of the entire personnel.

Many difficulties in establishing sound industrial relations lie in faulty organization. Lines of responsibility and authority from the chief executive to the lowest level of supervision must be defined clearly and responsibility of the line supervisory forces for interpreting the industrial-relations policies must be emphasized continuously. All members of the executive and supervisory staff, starting with the senior executives, should be trained in the interpretation of these policies.

In addition to defining clearly lines of responsibility, each company should make certain that the number of employees reporting to each foreman is limited. It is generally recognized that the foreman is the keyman in industrial relations. He must select, place, and train the men who report to him. He must protect them against injury, educate them in company policies and practices, rate them, transfer them, promote them, lay them off, recommend them for wage adjustments, consider their individual aspirations and grievances, and organize and supervise their work. In addition, he must discharge his responsibilities for buildings, equipment, processes, material, quality, output, and costs. Efficient achievement of these objectives will require a limitation on the number of workers reporting to him.

Coordination of the industrial-relations program of a company should be centralized in an industrial-relations department. In a small plant, this responsibility may be assigned to an executive with other duties. The industrial-relations specialist should report to the chief executive of the company because he, by nature of his office, is the chief industrial-relations man. The personnel specialist, therefore, should get his guidance and inspiration directly from the chief executive, and the latter should draw his advice and counsel directly from the industrial-relations man. In a company with a number of plants, each plant should have, in addition to the central personnel man, a local industrial-relations man reporting to the plant manager.

Some confusion may have arisen in the past because certain industrial-relations activities have been assigned to time-study men and the activities of these industrial engineers have not been coordinated by the industrial-relations man with the industrial-relations program. Problems of wage incentives, standards of human efficiency, and the like would logically appear to be primarily industrial-relations activities. It is the exception rather than the rule, however, to find such activities coordinated by the industrial-relations man. They have been considered as engineering rather than personnel problems. Some difficulty in the past can be traced to the fact that these activities have not been coordinated by the industrial-relations man, whose approach would have been more physiological and psychological than mechanical. It may be desirable in the future to assign such activities to the industrial-relations department and coordinate them with other aspects of the industrial-relations program.

Generalizing is difficult, but I have felt for some time that the approach of industrial engineers to human efficiency has been too mechanical. My opinion has been that industrial-engineering curricula of most engineering schools have not provided proper background in industrial relations, personnel management, industrial psychology, and industrial physiology. A recent exhaustive study of the literature on time study, motion study, and wage incentives made by Dr. Richard S. Uhrbrock (8) indicates the dearth of psychological and physiological background of the engineers who have contributed this material.

The industrial-relations man should also participate in long-range planning of technological changes. This will permit him to plan for adjustment of workers who may be displaced. In this way, retraining for other occupations, transfer to other work either within the company or in other companies, and development of adequate dismissal-compensation plans can be carried on in advance of actual changes.

PERSONNEL METHODS

After sound industrial-relations policies have been established and the management organization for carrying out these policies defined and coordinated, the problem of developing methods and techniques for solving the problems of scientific management in unionized plants remains. Some more important of these methods are

1 Procedures for collective cooperation
2 Grievance procedure
3 Technological changes
4 Establishing wage and hour standards
5 Time and motion study and wage incentives
6 Employment methods
7 Training methods
8 Shop discipline
9 Improving working conditions
10 General education

Collective Cooperation. We must study continuously techniques of collective bargaining, collective cooperation, and educating union leaders in management problems. We will have to exercise much patience in inculcating business knowledge in some union leaders with whom we will have to deal. For example, some unions must be educated to revise their policies relating to the concept that there is just so much work to go around. This concept is based on the faulty "lump-of-labor" economic theory.

Management must realize, however, that employees and their representatives usually approach these problems emotionally rather than logically. In this respect, they are human, because management cannot claim that its own approach to industrial-

relations problems has always been characterized by logical rather than emotional thinking. Getting men to abide by the facts of the situation is usually extremely difficult. Dr. Don H. Taylor cites an example (9) in the printing industry where it was impossible, during the introduction of new equipment and machinery, to get the union delegates to sit down to any calm analysis of the facts of the situation and reach an agreement based on them. Francis Goodell on the other hand was unusually successful in one plant (10) in getting the agreement of the union to abide by the facts.

Care should be taken not to make the union representatives too management-minded because of the danger that they may not properly protect the interests of their constituents and may consequently be repudiated and replaced by more radical leaders. Also, the union representatives should not be short-circuited in making improvements in wages, hours, and working conditions because these leaders may feel that they must demand additional improvements to convince their constituents that they are on the job. It is much better to introduce these improvements with the cooperation of the employees' representatives. Some foremen follow the practice of contemptuously asking their employees what the union is doing for them with the result that the workers may be stimulated to ask their representatives to demand additional concessions from the management.

The question has been raised as to whether wages, hours, and working-conditions agreements with a union can be combined with similar agreements for some form of employee representation to deal with the management on questions of purely "scientific management." In this connection, the suggestion has been made that the management consult the unions and ask them to designate employees of the company to cooperate in these matters. It is claimed that organized labor will respond constructively to such requests. Some students of labor problems believe, however, that such cooperation can be developed without union assistance.

Whether industries making extensive use of scientific management should deal with unions on a company or on an industry-wide basis is also a question. This would depend largely upon the nature of, and conditions, in the industry. In some industries, negotiating standards of wages, hours, and working conditions throughout the entire industry would seem desirable to prevent competition on the basis of worker exploitation. In many industries, however, this would not be practicable. New machinery and processes, time study and wage incentives, selection and training methods, and the like, on the other hand, would seem to be, in general, problems of the individual company and the union, because this will facilitate competition on the basis of managerial and technical skills.

Grievances. Many contracts with unions provide a standard formula for the handling of grievances. Management should seek continuously to discover grievances systematically and adjust them promptly. In addition to the formal grievance procedure, management should constantly endeavor to get at individual grievances and to settle them with dispatch.

Technological Changes. Cooperation of the union should be enlisted in introducing labor-saving machinery and improving plant methods and processes. This, of course, will present many difficulties but can be solved by painstaking personnel management. As indicated previously, long-range planning of the displacements that may be caused by technological changes should be practiced. Unions must be convinced that workers will share with stockholders and consumers in the gains due to these changes. Special retraining should be undertaken so that men to be displaced will have qualifications for other work. This may require that seniority provisions in union contracts be on a plant rather than a departmental basis. In some cases, training workers for transfer to jobs in other companies may be possible. Also, technical changes may result in lower costs and prices and no decrease in employment. In any event, liberal dismissal-compensation plans should be established which will enable the displaced worker to adjust himself if the other methods fail. However, negotiating such dismissal compensation plans on an industry-wide basis may be necessary. An example of such a plan may be found in the railroad industry.

Wages and Hours. Development of equitable wage schedules is a difficult problem of scientific management in unionized plants because many wage-adjustment agreements are made on the basis of blanket percentage adjustments of existing wage rates. This practice tends to perpetuate present inequalities in pay. In a number of cases, however, the problem has been solved satisfactorily. Job analysis, classification of jobs writing of specifications for each classification, and grading of these classifications should enable an equitable grading plan that will recognize relative degrees in job difficulty, training required, exposure to hazards, and the like to be worked out with union cooperation. After the relative grading has been agreed upon, wage rates for each grade, which will provide proper differentials, can then be negotiated.

Time and Motion Study, and Wage Incentives. Management may be compelled to revise its estimates of the value of incentive wage systems. Development of better methods of time and motion study will be a most difficult problem in unionized plants in the future. Much opposition has been shown by both organized and unorganized labor to wage-incentive plans. In many cases output has been restricted. However, in a number of instances, organized labor has cooperated in developing such plans. Their attitude depends largely upon whether employees have been consulted in establishing work standards and piece rates. Also, plans have been so complicated in many cases that the workers have not understood them and have, consequently, been suspicious.

No wage-incentive plan should be installed without cooperation of employees' representatives who should participate in establishment of work standards and piece rates. Unless a given plan is acceptable to them, it will not be a real incentive plan. No reason can be found why proper wage incentives should not be continued and expanded in industrial plants. If management is willing to develop standards of work with union cooperation, organized labor is not likely to object to these standards and the determination of employee efficiency. Much time will have to be taken, however, by management to discuss patiently with the employees' representatives actual techniques and standards of time and motion study and wage incentives. Management must win the confidence of employees that these methods are fair and accurate, and to do this, better techniques must be developed.

Psychologists, physiologists, and statisticians feel that methods of time and motion study need considerable improvement. Many weaknesses in current practices have been pointed out by the penetrating American Management Association papers of R. S. Uhrbrock, (11) H. W. Haggard, (12) and Irving Lorge (13) in this country and the studies of the Industrial Health Research Board in Great Britain (14). Every plant superintendent and industrial engineer should be familiar with these studies.

Psychologists believe that the tendency is to overrate the effects of wage-incentive plans, feeling that improvements in human efficiency which have been attributed to wage incentives come mainly from the job study that precedes or accompanies establishment of work standards. They are inclined to attach

much more importance to effects of selection, training, supervision, health, lighting, heating, ventilation, rest periods, arrangement of work, and the like.

In speeding up, physiologists see a danger of interference with the ordered working of the whole organism, stating that attention must not be limited to one group of muscles engaged in a task but must involve the physiology of the man's activity as a whole. They claim (15) that units of human work cannot be ticked out like seconds on a clock and that variations exist not only in a group but in each individual of it. Haggard (16) states that many physiological conclusions in the writings on motion study lack validity.

Statisticians have pointed out many flaws in the mathematics of time study which have appeared in standard works on the subject. They suggest use of the simplest statistics; arithmetical average, standard deviation, and correlation coefficient. Time-study data should be collected from an entire group of operators (17) rather than from one or two persons, so that "leveling" can be made according to the distribution of the trait under consideration rather than on some a priori scale.

An urgent need exists for intensive research in the field of time and motion study and wage incentives. These methods are far from being scientific at present. Until this research has been carried on and we have more facts about these devices, we will continue to have difficulty in convincing employees that our methods are fair and to their advantage. For example, we need more facts about the effects of the stretch-out and speed-up on the human organism. Our approach to the problem of human efficiency might be similar to that of the Industrial Health Research Board and the National Institute of Industrial Psychology of Great Britain. These physiologists and psychologists have done much toward economizing effort with mutual advantage to employees in increased contentment and efficiency and to employer in increased output and decreased costs.

Foremen should be trained in time-study, motion-study, and wage-incentive methods so that they can explain standards to the employees. Numerous cases of employee dissatisfaction with wage incentives can be traced to lack of foremen training in these methods. If the foremen have not accepted and do not completely understand wage-incentive methods, expecting employees to welcome such methods is not reasonable.

In any event, a long-range program of training employee representatives in these methods and enlisting their cooperation in the establishment of work standards should be undertaken. If time-study, motion-study, and wage-incentive techniques are sound, these representatives can be educated in the advantages of these methods to their constituents. However, the complications of an efficient wage-incentive plan may be too difficult for employees to understand, and in such an event, they must have implicit confidence in the integrity and ability of the technicians who install such systems.

Any incentive plan will have limitations because the rank and file have a tendency to restrict output and frown upon the efficient worker. Only by better employment stabilization and patient educational effort can this tendency be reduced.

Employment Methods. Interpreting and putting into operation seniority provisions in union contracts will undoubtedly be unusually difficult in the future. The C.I.O. formula that seniority shall govern promotion, layoff, and reemployment, if such factors as skill, training, number of dependents, and the like are equal, is reasonably simple. In actual practice, however, convincing employees that accurate and fair selection has been made will be difficult whenever necessity for making a number of these employment adjustments arises.

What is needed is development of better methods for measuring individual differences, including job specifications, qualification records, service records, earnings records, injury records, illness records, attendance and punctuality records, output and quality records, physical-examination records, rating scales, and the like. These, of course, are the tools of good employment management utilized by progressive industrial-relations departments. In addition, development of psychological tests under the direction of competent industrial psychologists offers tremendous possibilities. Competitive examinations will also facilitate selection for promotion. Developing such measures in cooperation with employee representatives should eventually make measurement of individual differences more accurate and impersonal and should reduce many of the difficulties that lie ahead in interpreting seniority provisions.

In a number of cases, the management of closed shops has experienced no difficulty in making a critical selection within the union membership. Ordway Tead (18) reports that certain unions have even developed psychological tests.

In connection with employment stabilization, employees will need to be trained for transfer to other jobs and transfers, promotions, layoffs, and reemployment must be made largely on a plant rather than a departmental basis. In states where unemployment-compensation laws provide for merit rating, the employer has a definite financial incentive to stabilize employment to a greater extent than he has had in the past. Therefore, discussing this problem at length with employee representatives will be desirable and working out with them, over a period of time, policies and methods that will facilitate better stabilization. All entrances, transfers, promotions, layoffs, and reemployment should be centralized in the employment office. If promotion is to be effected on a plant rather than a departmental basis, a grading plan must be developed which will group all classes of jobs into appropriate grades.

Training Methods. The number of apprentices to be trained may cause some difficulty in unionized plants. Many of these difficulties, however, can be traced to the unions' misunderstanding the requirements of the business. Here again, management will have to explain patiently to employee representatives facts about turnover of skilled workers, growth and needs of the business, turnover of apprentices, and how many new men should enter apprentice training each year. The Federal Committee on Apprentice Training is cooperating with employees and unions in training a sufficient number of highly skilled workers to supply the country's growing needs. National apprenticeship standards already have been developed for a number of trades.

Selection of men for apprentice or other forms of training should be facilitated by the employment techniques that have been indicated. A manufacturing company that is noted for its personnel research has used psychological tests with good results in selecting apprentices. Whenever selecting a group of apprentices is necessary, the opportunity to apply is given to all men in the plant. Those who apply are rated carefully by their foreman by rating scales and are given a battery of mechanical-aptitude tests and a mental-alertness test. By these measures of individual differences, final judgment is made relative to the men to be selected. The employees have expressed themselves as highly pleased with these methods.

Shop Discipline. Shop discipline should be facilitated by union-management cooperation. Employers will find that responsible unions are anxious to cooperate in this matter. Definite standards should be worked out by cooperative effort. For example, it should be possible to develop standard reasons for discharge. That the right to discipline employees is vested in the management, should be clearly understood, however, provided that this right will not be used for discrimination against any member of the union. On the other hand, all com-

plaints of unfair discharge may be handled through the regular grievance procedure.

Working Conditions. Aid of the union should be enlisted in the improvement of physical working conditions. It should be possible through such cooperation to improve safety, health, sanitation, facilities with which to do work, and the like.

General Education. Management should begin at once a program of continuous education for employee representatives in facts about the company, the industry, and the fundamentals of economic society. Facts should be presented about the company's earnings and financial position and the earnings of employees. Problems of costs and prices should be discussed. Plans of the management for ensuing budget periods should be outlined. The competitive position of the company in the industry should be discussed as well as competitive problems of the industry as a whole. Such discussions should logically lead into an explanation of economic fundamentals. Policies of labor unions based on the faulty lump-of-labor theory should receive early attention. Effect of shorter hours and higher wages on employment should be explored. Psychological facts about individual differences should be explained. In this way, employee representatives should learn more about the problems of the management and develop greater business responsibility. Presentation of financial facts about the company should be made in such a way that employees will know that they are participating properly in increased gains resulting from scientific-management developments and that they are getting their fair share of the company's earnings.

CONCLUSION

In a large number of cases unions have opposed scientific-management practices, but, on the other hand, they have also cooperated in introducing scientific-management methods. The attitude of the unions seems to depend to a large extent on the personnel policies and methods of the management. Employees are naturally suspicious about changes that they do not understand and about which they have not been consulted. In this, they are wholly human. Whether or not unions are consulted in management problems directly affecting them, will probably determine their attitude more than any other single factor. If changes in machinery, processes, methods, and the like are worked out with their advice and cooperation, they are likely to help introduce changes that they might otherwise oppose. On the other hand, craft unions are likely to oppose changes that they believe will eliminate need for certain craft skills. Also, unions will need some assurance that unemployment will not result from the proposed changes. However, if employee representatives understand that the company is in a competitive situation requiring cost reductions and unemployment will result unless costs are reduced, they are likely to cooperate in improvements.

Management must be unusually patient and not easily discouraged in its attempt to develop union-management cooperation. Education is a slow process. Human habits cannot be changed overnight. Employees are more prone than management to react emotionally rather than logically to scientific-management problems. On the other hand, management has not always been entirely logical in matters of industrial relations. Many industrial-relations men state privately that their most difficult problem has been educating the management. We should not become discouraged, therefore, if first efforts in educating union leaders do not produce immediate results.

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Alumni of the

ENGINEERING COLLEGES

By DONALD B. PRENTICE

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FIVE YEARS ago a study was made of the college antecedents of engineers whose biographies appeared in the third edition (1931) of "Who's Who in Engineering."[1] A similar analysis has been carried out for the fourth edition that was published last year. Editorial policy for the 1937 volume followed the plan adopted for the earlier edition. Questionnaires were mailed to 176,000 engineers whose names were included in the census recently made by the U. S. Department of Labor. This list had been developed from the membership of the national engineering societies. An advisory board of prominent engineers established the qualifications for inclusion in the volume, and the professional aspects of the work were governed by American Engineering Council. While it is admitted that some engineers whose attainments deserve recognition are not listed in the 1937 edition because they did not return the questionnaires, yet it undoubtedly provides the most reliable information in regard to the leaders of the profession.

In compiling the statistics for the present article, the same procedure was followed as in the earlier analysis. The results of the two studies are, therefore, directly comparable. Approximately 12,000 biographies appear in the 1937 volume, about 5 per cent more than in the 1931 edition. In assigning the individuals to various colleges an arbitrary rule was adopted. The college that conferred the first degree which represented education in the professional field was given credit for the alumnus. Graduates of engineering schools were assigned to those schools even though advanced degrees were received later from graduate departments of other institutions. Graduates of arts colleges, however, who continued their studies in engineering schools were credited to the latter. In some instances, biographies of geological or chemical engineers report graduation from arts colleges and the receipt of the doctor's degrees in geology or chemistry from universities. These individuals were credited to the colleges from which they received their first degrees, on the theory that the preliminary study of their professions was done as undergraduates. A graduate of Oberlin, for example, who received an engineering degree a few years later at Illinois was assigned to Illinois. A graduate of Oberlin, however, who later received the degree of Ph.D. from Chicago for a major in physics was credited to Oberlin. A graduate of Armour who continued his study of engineering at Illinois and received a second degree was recorded for Armour.

In the 1937 edition of "Who's Who in Engineering" are 9845 biographies that definitely claim graduation from a college in the United States or Canada. Graduates of foreign institutions, other than Canadian, were omitted from this study. Undoubtedly actual graduates are slightly more than the number given, for only those were counted who reported the degree or the fact of graduation. In a few cases, the name of a college appeared in a biography with no indication of the period of attendance or the academic success. In the 1931 edition, 8643 college graduates, determined on the same basis, were listed. The increase of 1202, or 13.9 per cent, indicates in part the larger number of biographies, but chiefly the increased responsibility of college-trained engineers in the profession.

Table 1 gives the number of graduates of the various colleges listed in the third and fourth editions of "Who's Who in Engineering" with the numerical changes. The list is carried down to those colleges of whose alumni seven are included in the 1937 volume. In addition to those named, 165 colleges had six or less alumni included, for a total of 371, or less than 4 per cent of all graduates. The corresponding figures for 1931 are 153 colleges and 357 graduates, which is approximately the same percentage of all graduates.

The greatest numerical increase between the 1931 and 1937 volumes was made by the Massachusetts Institute of Technol-

TABLE 1 GRADUATES OF 142 COLLEGES AND UNIVERSITIES OF THE UNITED STATES AND CANADA LISTED IN THE 1931 AND 1937 EDITIONS OF "WHO'S WHO IN ENGINEERING"

No.	College	Number of graduates listed 1931	1937	Increase	Decrease
1	Massachusetts Institute of Technology	664	761	97	
2	Cornell	562	611	49	
3	University of Michigan	385	460	75	
4	University of Illinois	295	364	69	
5	Purdue	254	309	55	
6	University of Wisconsin	269	305	36	
7	Columbia	282	292	10	
8	Yale	256	270	14	
9	Ohio State University	192	254	62	
10	University of California	207	229	22	
11	Harvard	190	200	10	
12	University of Pennsylvania	179	197	18	
13	University of Minnesota	157	182	25	
14	Lehigh	201	175		26
15	Iowa State College	144	171	27	
16	Pennsylvania State College	110	147	37	
17	Worcester Polytechnic Institute	145	147	2	
18	Stanford	145	132		13
19	Rensselaer Polytechnic Institute	120	125	5	
20	University of Kansas	119	124	5	
21	Stevens Institute of Technology	122	122		
22	University of Nebraska	93	111	18	
23	University of Washington	82	107	25	
24	Case School of Applied Science	85	105	20	
25	Michigan College of Mining and Technology	96	100	4	
26	University of Colorado	80	92	12	
27	University of Missouri	82	92	10	
28	Armour Institute of Technology	82	80		2
29	Maine	71	79	8	
30	U. S. Military Academy	92	78		14
31	Colorado School of Mines	82	76		6
32	Washington University (St. Louis)	67	73	6	
33	Rose Polytechnic Institute	71	69		2
34	Michigan State College	66	68	2	
35	Princeton	68	68		
36	Dartmouth	60	67	7	
37	Cincinnati	41	64	23	

(*Table 1 continued on following page*)

[1] "The Product of Engineering Colleges," by Donald B. Prentice, MECHANICAL ENGINEERING, October, 1932, pp. 700–702.

TABLE 1 (*Continued*)

No.	College	Number of graduates listed 1931	1937	Increase	Decrease
38	U. S. Naval Academy	56	64	8	
39	Syracuse	56	64	8	
40	University of Texas	42	62	20	
41	Brown	48	61	13	
42	University of Iowa	43	56	13	
43	Kansas State College	60	55		5
44	University of Kentucky	48	55	7	
45	Tufts	39	54	15	
46	Johns Hopkins University	38	53	15	
47	University of Chicago	35	52	17	
48	Union (Schenectady)	43	52	9	
49	Carnegie Institute of Technology	35	51	16	
50	Cooper Union	41	51	10	
51	Georgia School of Technology	33	51	18	
52	Lafayette	40	49	9	
53	Brooklyn Polytechnic Institute	38	45	7	
54	Missouri School of Mines	55	44		11
55	Pittsburgh	37	44	7	
56	Rutgers	40	43	3	
57	Tulane	34	42	8	
58	Texas A. & M.	34	41	7	
59	University of Virginia	24	41	17	
60	University of Utah	30	40	10	
61	New York University	36	39	3	
62	Ohio Northern	31	39	8	
63	College of the City of New York	28	37	9	
64	Virginia Polytechnic Institute	37	37		
65	Toronto	28	36	8	
66	George Washington University	28	35	7	
67	California Institute of Technology	19	34	15	
68	Vermont	28	33	5	
69	West Virginia University	33	33		
70	Alabama Polytechnic Institute	28	32	4	
71	State College of Washington	20	32	12	
72	Oregon State Agricultural	20	30	10	
73	Indiana University	24	29	5	
74	McGill	35	27		8
75	University of Oklahoma	27	27		
76	Swarthmore	22	27	5	
77	Clemson	12	26	14	
78	University of Arkansas	24	25	1	
79	University of North Carolina	23	25	2	
80	Virginia Military Institute	23	25	2	
81	Bucknell	13	24	11	
82	Northwestern University	15	24	9	
83	Colorado State College	19	22	3	
84	New Hampshire	13	22	9	
85	North Carolina State College	18	22	4	
86	University of Tennessee	17	21	4	
87	Colorado College	14	19	5	
88	University of Idaho	12	19	7	
89	North Dakota University	15	19	4	
90	Oklahoma A. & M.	12	19	7	
91	Mississippi State	16	18	2	
92	Norwich	19	17		2
93	Denison	15	16	1	
94	Rochester	15	16	1	
95	South Dakota A. & M.	13	16	3	
96	University of Alabama	5	15	10	
97	Lewis Institute	9	15	6	
98	South Dakota State School of Mines	11	15	4	
99	Vanderbilt	17	15		2
100	Marquette	12	14	2	
101	University of Notre Dame	12	14	2	
102	Valparaiso	15	14		1
103	University of Detroit	4	13	9	
104	Rhode Island State	12	13	1	
105	Washington & Lee	16	13		3
106	Clarkson College of Technology	14	12		2
107	Delaware	5	12	7	
108	Haverford	8	12	4	
109	University of Oregon	7	12	5	
110	Trinity (Hartford)	8	12	4	
111	Williams	11	12	1	
112	Arizona	9	11	2	
113	Cornell College	16	11		5
114	Highland Park	9	11	2	
115	Queens	17	11		6
116	Amherst	14	10		4
117	Colgate	9	10	1	
118	Montana State University	8	10	2	
119	Nevada	13	10		3
120	Ohio Wesleyan	7	10	3	
121	Allegheny	11	9		2
122	University of Florida	10	9		1
123	Louisiana State University	10	9		1
124	Ohio University	6	9	3	
125	South Carolina	6	9	3	
126	Southern California	7	9	2	
127	Wesleyan	6	9	3	
128	Drexel	4	8	4	
129	Earlham	9	8		1
130	Franklin & Marshall	3	8	5	
131	University of Georgia	11	8		3
132	Grinnell	7	8	1	
133	University of Mississippi	3	8	5	
134	Montana A. & M.	7	8	1	
135	North Dakota Agricultural	3	8	5	
136	Northeastern	3	8	5	
137	Rice	3	8	5	
138	Albion	5	7	2	
139	Oberlin	8	7		1
140	Webb		7		
141	Western Reserve	6	7	1	
142	College of Wooster	4	7	3	
	Colleges having 6 or less	357[a]	371[b]	14	
	Total	8643	9845		

[a] Representing 153 colleges.
[b] Representing 165 colleges.

TABLE 2 GEOGRAPHICAL DISTRIBUTION OF COLLEGES HAVING THE GREATEST NUMBER OF ALUMNI LISTED

State	Colleges	Alumni listed
New York	14	1439
Massachusetts	7	1192
Pennsylvania	12	751
Michigan	5	648
Illinois	5	535
Ohio	10	518
Indiana	6	443
California	4	404

TABLE 3 DATA ON LIVING ALUMNI OF 12 ENGINEERING EDUCATIONAL INSTITUTIONS OF SIMILAR TYPE

	Total	Included in "Who's Who in Engineering" Number	Per cent
Michigan College of Mining and Technology	1630	100	6.13
Massachusetts Institute of Technology	14000	761	5.44
Rose Polytechnic Institute	1498	69	4.61
Worcester Polytechnic Institute	3246	147	4.53
Colorado School of Mines	2018	76	3.77
Stevens Institute of Technology	3283	122	3.72
Case School of Applied Science	3600	105	2.92
California Institute of Technology	1244	34	2.73
Rensselaer Polytechnic Institute	4888	125	2.56
Armour Institute of Technology	3399	80	2.35
Clarkson College of Technology	1206	12	1.00
Georgia School of Technology	5500	51	0.93

ogy. Among the institutions with 100 or more alumni listed, the greatest percentage gain was made by Pennsylvania State College with Ohio State University a close second. In this group are 12 private and 13 state institutions. The former have 3137 and the latter 2863 alumni listed, or 52.3 and 47.7 per cent, respectively. Compared with similar figures from the 1931 volume, this represents a gain for the state institutions.

From a geographical point of view, distribution of the colleges listed in Table 1 is partly as given in Table 2.

New York State institutions have trained 15.2 per cent of the college alumni, and 21.6 per cent of all the engineers included in "Who's Who in Engineering" are residents of the state. On the other hand, Massachusetts colleges have graduated 12.5 per cent, while industries of the state employ only 7.5 per cent.

Colleges of the Middle Atlantic States of New York, New Jersey, and Pennsylvania, together, have 2423 alumni listed in the table; the north central colleges in Michigan, Ohio, Indiana, and Illinois contribute 2144 graduates; and the New England institutions, 1775. It is interesting to note, also, that nearly one fourth of all college-trained engineers listed in "Who's Who in Engineering" were graduated from M.I.T., Cornell, Michigan, and Illinois, and nearly one half are alumni of the first fifteen institutions in the Table 1.

Institutions of similar type can be compared on the basis of the percentage of living alumni whose biographies are included in "Who's Who in Engineering." Table 3 gives these figures for 12 independent engineering colleges, the alumni totals having been furnished by the registrars of the respective schools. It is not feasible to include university engineering schools in this table as graduates in chemistry, physics, or geology are occasionally listed in "Who's Who in Engineering." It would not be fair to consider living alumni of the engineering college alone, nor the total for both engineering and arts colleges. It is practically impossible to separate alumni of arts and engineering colleges on their records in "Who's Who in Engineering," for, in many institutions, degrees of B.S. are conferred by both colleges.

WHAT ARE OUR MENTAL RESERVES?

By S. MARION TUCKER

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NO SCIENTIST or technologist has any trouble in finding material for his purely professional speeches. He has it right at hand, or he would not talk at all. He has a direct professional incentive to speak, or, rather, to prepare and read "papers," because in his laboratory and workshop he has found out something that he believes ought to be said. He knows also just what sources of outside information are open to him—the discoveries of other men as stated in his professional magazines, society bulletins, and monographs. He molds his material into a statement of scientific facts, perhaps also ideas, which is purely technical and is complete in itself. It may have no direct relation to the world outside, need not have any, and is not expected to have any. His paper on "Armature Leakage Resistance," or "Solvent Refining of Oils," or "The Physical Properties of Petroleum" is a contribution to his specialty. That is surely enough. If he has something authentic to say, he has done a good job.

Now, no doubt many of the men who produce these hundreds of such contributions are quite capable of connecting their subjects with the world outside if the subjects demand, or even suggest, any such treatment. When they discuss "Utility Companies and the Government," or "Politics and Industrial Chemistry," or "Hydropower in Relation to Economic Conditions," they take their science with them into the fields of politics, economics, and sociology, thus relating them to the world of affairs. They see that science does not stand apart but is actually a determining factor in society—in the quality and quantity of our food and the clothes we wear and what we pay for them; what kind of houses we live in; the water we drink; the way we travel and the cost of it; the rate of our taxes. The list is endless; it includes just about everything that pertains to present human living. We know the appalling waste that has resulted from the lack of proper planning of engineering projects in the past, the overlapping of public utilities—gas, light, water, and power and the unnecessary duplication of facilities; the misspending of vast sums for things not needed or bound to prove unproductive—resulting either from lack of foresight or from unintelligent greed or from both. All this explains and fully justifies the entrance of the scientist and technologist into the wider world of human affairs, not simply as a builder but as an adviser. Thus, he makes a double contribution to society. But not often enough. Too often, he is handicapped by narrow interests and overspecialization, seeing clearly the facts of his laboratory or workshop but blind to those outside, indifferent to the purely human forces that finally determine the ultimate value of his own products. Lester Allington is a typical case.

Allington was born with what is loosely called "the scientific mind;" that is, like all normal boys, he loved trains, automobiles, airplanes, and radio and liked to use his hands in contriving all kinds of mechanical devices. At any rate, he took to engineering with avidity and did well at college. His courses, aside from physics, chemistry, and mathematics, were all purely technical. There was no hint in them of the real world in which he would have to do his work—not a word about the social, economic, and political conditions that would ultimately dictate his failure or success. Although he would have to deal with human beings and build with human flesh and blood as well as with concrete and steel, would have to meet employers and employees, would have to buy and sell, and would have to influence human conduct, he learned nothing of applied psychology; indeed, he never heard of it. Thus his college training narrowed him even beyond his natural bent.

THE DEHYDRATION OF LESTER ALLINGTON

After he was graduated, he had to scramble for a living and keep his eyes only on his profession. Soon he joined the American Society of Dehydrating Engineers and became especially interested in division 79, which concerns itself ex-

[Professor Tucker, who will be remembered because of his lectures on "Talking With an Audience," at several A.S.M.E. Annual Meetings, has learned much about technical men from his contacts with them and from their platform appearances. His keen observations on speakers and their techniques are recorded in a series of spritely articles, of which this is the first to appear.—EDITOR.]

clusively with the dehydration of prunes. He worked hard in the laboratory and read all the technical magazines religiously and every line that was printed on his specialty. Well, Allington has indeed succeeded, according to his own standard, and society in general owes him a debt for his practical contribution to the common good in his invention of the now celebrated Allington Process, which has materially cheapened the price of prunes. Who shall be the one to say that he is not a benefactor.

But in the meantime he himself has become as thoroughly dehydrated as one of his own products. When he makes a speech, he puts his colleagues to sleep. Socially, he is a dead weight. This, of course, is negligible as concerns Allington himself; he likes it that way. But it is unfortunate for society. Allington is a victim of his own specialization, which from his college days on has narrowed him down to almost the vanishing point. He can see no relation between his own scientific interests and the world of humanity. He hasn't read a book outside of his specialty for twenty years. He is as dry as dust.

THE PHENOMENAL CASE OF JULIUS LAMBTON

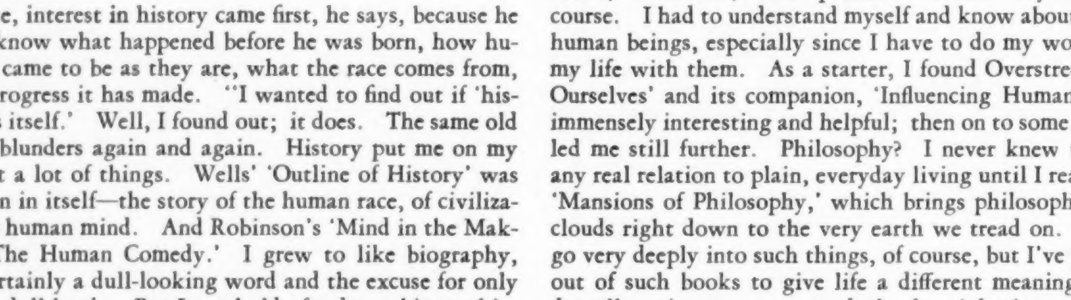
You don't have to argue with Lambton about general reading. He is as juicy as Lester Allington is dry; yet, apparently, his juiciness has not adversely affected his scientific output or his professional status, for he is one of the best. He acquired an interest in general reading in college, strangely enough, and within the twenty years since he was graduated, he has added about fifty books a year to the collection that he began in his college days.

In his case, interest in history came first, he says, because he wanted to know what happened before he was born, how human affairs came to be as they are, what the race comes from, and what progress it has made. "I wanted to find out if 'history repeats itself.' Well, I found out; it does. The same old follies and blunders again and again. History put me on my guard about a lot of things. Wells' 'Outline of History' was an education in itself—the story of the human race, of civilization, of the human mind. And Robinson's 'Mind in the Making' and 'The Human Comedy.' I grew to like biography, which is certainly a dull-looking word and the excuse for only too many a dull book. But I got hold of a dozen biographies that fascinated me as the revealing story of unusual human beings. This really is life itself. This shows what people really are. Those biographies supplemented and illustrated everything I had studied in psychology and had observed about me in the people I met.

"My next interest was in travel, exploration, and adventure. These books covered the world, took me everywhere, showed me all of human life, incidentally taught me geography, geology, botany, all sorts of things. What a book that story of the 'Eastern Odyssey' is, for instance—all Asia from east to west and west to east. Then, when I bought that little place up country, I got interested in natural history, for there certainly was enough of it all around me. Did you ever read Fabre's 'Social Life in the Insect World?' Reads like a novel—incredible! Beebe's 'Jungle Peace' and 'Nonsuch'—fifty others on animals, insects, birds, plants, rocks, everything. I read them just for fun, but, do you know, they helped to make life more interesting. Incidentally, they gave me a lot of material that I can use when I talk and write and speak. I have read some novels and some plays, too, and even some poetry. The poetry came last, and will last longest, I begin to believe. I used to be shy about this, but now I see that poetry, although most people think it moonshine and nonsense, is the final expression of everything that matters—that it shows us what is eternal and immutable in our inconsistent and changing world, and says it finally and beautifully. A strange statement from a scientist, no doubt; but I have come to the point where I can afford to be thought queer. Finally, there's the Bible, not for religious purposes so much but simply, at least in some parts, as really great literature. How much it knows about plain old human nature, the elemental things of life; and some of it is wonderfully written. It runs all through our literature and all through our lives, if we only knew it. It gives a man a lot of material to use as illustration, too, and a multitude of apt and concise phrases that say a great deal. It has a very direct relation to public speaking," said Lambton.

"Economics, sociology, political science, and all that? Oh, yes, of course; but I was thinking especially about general reading and not about the things that the scientist must know as essential background for his work. We take all that kind of reading for granted nowadays, though I have heard of some benighted persons who don't yet realize that they're living in a social, economic, and political world. Psychology? Of course. I had to understand myself and know about my fellow human beings, especially since I have to do my work and live my life with them. As a starter, I found Overstreet's 'About Ourselves' and its companion, 'Influencing Human Behavior' immensely interesting and helpful; then on to some others that led me still further. Philosophy? I never knew that it had any real relation to plain, everyday living until I read Durant's 'Mansions of Philosophy,' which brings philosophy from the clouds right down to the very earth we tread on. I couldn't go very deeply into such things, of course, but I've got enough out of such books to give life a different meaning, and incidentally, give me a great deal of satisfaction. Superficial? Well, yes, of course, and why not? Was it Pope who said 'A little learning is a dangerous thing?' Well, he was right, if he meant that a man may mistake a little for a great deal, think himself wise when he is ignorant, well-done when he's only half-baked. And, no doubt, that's just what he did mean. But certainly even a very little learning is better than sheer ignorance or indifference, if it's real learning and not a sham. It at least opens our minds to possibilities, makes us receptive, even makes us dissatisfied with our ignorance—and if that isn't a good thing, I don't know what is."

Lambton may be all wrong, and perhaps he is really the rather eccentric person that some say he is; but at least he has the courage of his convictions; and, as far as his reading goes, he certainly has made it practically useful.



Courtesy the Midvale Co.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Day by Day

WINTER is the season for engineering-society meetings on a national scale—ushered in by the mechanicals early in December, and followed by the civils and electricals in January. The miners started their 1938 meeting on St. Valentine's day, too late to admit of report in this issue with the notes on the civils' and electricals' meetings, which follow.

Civils

For the better part of two weeks in January the lobby of the Engineering Societies Building, in New York, was gay with flowers and crowded with engineers, while the 85th Annual Meeting of the American Society of Civil Engineers was in progress, Jan. 19 to 22, quickly followed on the succeeding week by the Winter Convention of the American Institute of Electrical Engineers.

The Civils' meeting, which brought out an attendance of 2300, opened with official reports, the conferring of honorary memberships, the presentation of society medals and prizes, and a business session. Otis E. Hovey, member, A.S.M.E., and treasurer, Am.Soc.C.E., was one of those upon whom honorary membership was conferred. Others were George S. Davison, J. R. Worcester, and the late Hunter McDonald. Among the recipients of prizes was Boris A. Bakhmeteff, member, A.S.M.E., who received the James Laurie prize for a paper "The Hydraulic Jump in Terms of Dynamic Similarity," written in collaboration with Arthur E. Matzke, with whom the prize was shared. At the Los Angeles meeting of the A.S.M.E., to be held in March, Prof. Bakhmeteff and Mr. Matzke will present another paper on hydraulic jump, in this case concerned with sloped channels.

POWER

Of interest to mechanical engineers was a symposium on the cost of power, held under the auspices of the Power Division, which continued discussions initiated at the 1936 meeting of the Civils held at Pittsburgh, where the subject was "Economic Aspects of Energy Generation." A third symposium, on the subject, "Ultimate Cost of Power to the Consumer," is planned for some future date. At the Pittsburgh symposium two closing papers were presented by economists. At the New York meeting, all papers were by engineers, but economists were invited to discuss the closing paper.

The New York symposium included papers on "Elements of Power Costs," by John C. Page, Commissioner, U. S. Bureau of Reclamation; "Cost of Heat-Generated Power," by C. F. Hirshfeld, The Detroit Edison Company, member A.S.M.E., and R. M. Van Dusen, Jr., of the same company; "Cost of Hydro-Generated Energy," by H. K. Barrows, of the Massachusetts Institute of Technology; "Cost of Combined Energy Generation," by Ezra B. Whitman, consulting engineer, of Baltimore, member A.S.M.E.; "Cost of Depreciation and Obsolescence in Energy Generation," by Maurice Scharff, consulting engineer, of New York; "Cost of Power," the closing paper, by Wm. F. Uhl, of Charles T. Main, Inc., Boston, member A.S.M.E. Among the discussers were Daniel W. Mead, of the University of Wisconsin, member A.S.M.E.; A. G. Christie, of The Johns Hopkins University, member A.S.M.E.; L. N. McClellan, of the Bureau of Reclamation; T. B. Parker, TVA; H. G. Gerdes, Federal Power Commission; Philip Sporn, American Gas and Electric Service Corporation; James C. Bonbright, professor of finance, Columbia University; Leverett S. Lyon, The Brookings Institution; and John T. Madden, School of Commerce, Accounts, and Finance, New York University.

The mere listing of the foregoing names provides evidence of the attempt that was made to secure as many points of view as possible on an important national problem. It is easy to see that the three symposia, which started in the least controversial of the areas of the power problem where discussion would be confined to strictly engineering analyses, is progressing into those where more heat than light may be generated. At the New York symposium criticism and defense of the government's entry into the power field flared up again. Surely, the potentialities of controversy inherent in the subject proposed for the third symposium are great. Papers and discussions of the Pittsburgh symposium were published in the Transactions of the A.S.C.E., vol. 102, 1937, and it is understood that *Civil Engineering* will carry, in the March issue, abstracts of the papers presented in New York in January.

Mr. Hirshfeld, who frankly admitted that "history shows that man is . . . . . a very poor prophet," ventured, nevertheless, among the hazards of prophesy in the concluding paragraphs of his paper. He said: History also indicates that as man approaches the ultimate performance with one type of equipment or method he develops the ability to produce a new radically different, and better one. It may be that this is indicated in the present instance by the activity in the field of fuel cells; that is, equipments somewhat similar to electric batteries in which fuel is consumed and electric power produced as a result. This development has gone on almost unnoticed by power-plant men until there is now operating in laboratory size a very promising sample of such a cell. No one can say whether it can be enlarged sufficiently and commercialized, but careful investigation appears to indicate great probability thereof. Many difficulties can be foreseen but none appears now to be of insurmountable character.

The promise is, he continued, for thermal efficiencies of the order of double or more than double those presently attainable, and with a unit investment not greater than that now required, possibly even less.

About a quarter of a century ago, said Mr. Scharff in opening

his paper on cost of depreciation and obsolescence, a special committee of the American Society of Civil Engineers undertook a study of the problem of valuation of the public utilities, the final report on which, published in the Transactions of the society for November, 1917, achieved recognition as an important contribution to the literature of this controversial subject. Not that this report ended the controversy. On the contrary, he continued, it has raged unabated down to the present time, and has lost none of its vigor, as has been demonstrated within the last few weeks, by renewal of the old debate over the relative merits of "prudent investment" and "fair value," as a basis for public-utility rate making.

His paper contained the interesting proposal that the American Society of Civil Engineers invite the cooperation of engineers of other branches of the profession specializing in the design, construction, and operation of power plants in undertaking to devise more complete objective standards for the measurement of the effects of deterioration of power-plant structures and equipment, and of suggesting improved methods of arriving at sound engineering judgments and valid statistical inferences in the light of such objective standards as are already available.

VARIABLES

A study of the papers comprising the symposium, wrote W. F. Uhl in the "closing paper," indicates that the cost of generating power is indeed a variable quantity. This is a well-known fact which it should be unnecessary again to discuss at length, but many recent statements emanating from sources that should be well informed indicate that the belief is abroad that power should be produced at a fixed price, or that a yardstick of some kind can be set up to measure the cost of power. It is clear, he continued, that, considering all the variables, it must be a mere accident if the cost of power generated in any two or more stations is the same.

Mr. Uhl summarized some of the more important conclusions of his paper as follows:

The total cost of producing power consists of fixed charges and operating costs. Fixed charges constitute the principal cost in producing hydro power and are also a major item of cost in producing steam power.

The capital cost of power plants, both steam and hydro, is variable, depending upon many factors, principally on location and nature of service to be rendered.

The cost of power generation is also variable, depending principally on the cost of fuel and the output of the plant in the case of steam plants, and upon the capital cost and the available stream flow in the case of hydro plants.

Reliability of power supply is an important factor and one which may affect both the capital and operating costs of power plants.

Steam and hydro plants are seldom economically competitive but usually complementary if used to best advantage.

When investments are made in large new power plants, the output can seldom be absorbed immediately, and in the case of some of the large hydro plants, not for many years. In such cases the yearly fixed charges and maintenance costs on the unused portion of the plants, less credit for increased economy of operation, if any, must be added to the capital cost of the plant until it is fully utilized.

Particular attention should be called to the difference in cost of steam power from plants designed with full auxiliaries and reserve capacity, and those designed for less reliable service.

Abundance of reliable power is of much greater importance than cheap power from unreliable sources.

The power industry is of increasing importance to the welfare of the nation and has made tremendous contributions to its wealth and income.

Electricals

Treading on the heels of departing civil engineers, members of the American Institute of Electrical Engineers took possession of the Engineering Societies Building and the Engineers' Club in New York during the week of January 24. A program of 21 technical sessions, 17 inspection trips, numerous committee meetings, luncheons, a smoker, and the Edison Medal presentation, which culminated in a dinner dance and buffet supper at the Plaza on Thursday night, attracted 1438 persons to the winter convention.

Members had an opportunity of noting the initiation of a new publication plan. For several years the Transactions of the Institute have been combined with its monthly journal, *Electrical Engineering*, and papers for presentation have been published in advance of the meeting in this periodical. Recently, however, decision has been reached to separate the two publications and to provide photo-offset typescript copies of the papers at the meetings. A charge of 5 cents the copy, or 10 cents if ordered by mail, is made for these preprints. After the meeting, according to the plan, some of the papers will be published in Transactions and others in a portion of the Transactions issued monthly as a part of *Electrical Engineering*. Abstracts of Transactions papers not published in *Electrical Engineering* will, nevertheless, appear in that periodical. Transactions, issued in bound form annually, will include the papers previously published in *Electrical Engineering* section of the Transactions, and the others that were merely abstracted in the monthly periodical.

TRACTION

Among the technical sessions of interest to mechanical engineers were those devoted to modern electric vehicles and electric welding. Other sessions were given over to communication, radiation fields, lightning protection, electronics, relays and reactors, sound and vibration measurement, instruments, basic sciences, power transmission, electrical machinery, linear networks, definitions, television, and cables and research.

In a paper on the P.C.C. (Presidents' Conference Committee) car, C. F. Hirshfeld, chief engineer, Transit Research Corporation, member A.S.M.E., stated that the car in question is the result of a collective effort to improve the street car. Following an extensive investigation, car and equipment designs were produced. The resulting car is more agile and has been given a better appearance and better performance in many respects that affect the passenger. In spite of the addition of equipment not used in the older cars and of many refinements of design, the P.C.C. car is obtainable at a price which appears to meet economic requirements. Extensive use of rubber has greatly reduced noise and has improved riding comfort. More than 500 of these cars are already in use in seven cities of this country.

Closely allied with Mr. Hirshfeld's paper was one by T. Fitzgerald, Pittsburgh Railways Co., entitled "Results of Operations of P.C.C. Cars in Pittsburgh." With 201 of the cars purchased and 140 delivered and in service by November, 1937, experience with mechanical and electrical performance proved satisfactory and better than had been anticipated. The cars are said to attract and hold patronage, and, in Mr. Fitzgerald's opinion, "are an adequate answer to the charge of obsolescence of street railways."

Operating experiences with trolley coaches in Portland, Ore., and Boston, Mass., were described by James H. Polhemus and

Edward Dana, respectively; the papers may be found in *Electrical Engineering* for December, 1937.

In discussing operating experiences with gas-electric-drive motorbusses, R. H. Stier, Philadelphia Rapid Transit Co., said that most of the P.R.T. fleet of gas-electric busses are between 11 and 12 years old, and in view of the imminent purchase of new equipment the controversial question as to whether or not the electric drive should be utilized must be answered. The paper analyzes the problem presented in the choice between gas-electric and mechanical-drive busses, the selection being fundamentally a question of economics. The conclusion is that in frequent-stop, heavy-traffic urban service the electric-drive bus will produce a higher net income than the mechanical-drive vehicle.

E. J. McIlraith, Chicago Surface Lines, considered the broad subject of modern city transportation in a paper bearing that title; and C. M. Davis, General Electric Co., and S. B. Cooper, Westinghouse Elec. & Mfg. Co., presented other papers relating to electric vehicles and electric equipment for urban transportation, which may be found in *Electrical Engineering* for January, 1938.

WAGES

Speaking on the subject "Technological Development in Relation to Economics" on the day following President Roosevelt's warning to industrialists to maintain high wages and reduce prices, Harold G. Moulton, president, the Brookings Institution, ran head-on into a ready-made publicity market. The Metropolitan press picked up Dr. Moulton's comments on wages, contained in an address to the electricals, and editorialized on them for several days.

Dr. Moulton pointed out that we are all interested in a common goal, higher standards of living for the population as a whole. Disagreements, he said, relate almost entirely to the methods by which the desired goal is most likely to be attained. He summarized events leading up to the economic conditions at present prevailing, which he characterized as "the new business reaction," and said that if we are to restore standards of living to the predepression level or higher, we must, in order to make good accumulated deficiencies, have a level of production for some years to come substantially above that of 1929, while we are making up these averages.

Turning his attention to production requirements, he stated the task before the country in the following general terms:

First, to make good the actual deterioration of plant and equipment, sustained during the depression. Second, to increase productive capacity in proportion to the growth of population that has occurred. And third, to expand the output of consumption goods in accordance with this growth of population. Referring to studies he had made he said: Taking the whole field of durable goods into account and stating the results in aggregate terms, we found that the volume of production over the five years from 1937 to 1941, inclusive, would have to be roughly 60 per cent greater than it was in 1936, and approximately one third greater than it was during the boom period of 1925 to 1929.

But it was in his discussion of labor requirements that Dr. Moulton attracted the greatest attention. Investigations he carried out indicate that in the field of capital goods and durable consumer goods from eight to nine million workers will be required annually over the next five years to carry through the production program he had outlined as constituting the minimum requirement for a restoration of former standards of living. While less increased production and labor will be required in the nondurable consumer-goods field, he said, the work requirements to restore living standards during the next five years are more than sufficient to absorb the entire volume of unemployment now existing. Our research, he continued, reveals that anyone who favors a further general reduction of the working week at this stage of our economic development is unwittingly favoring lower standards of living.

In discussing wage and price relationship, Dr. Moulton called attention to two fundamental principles: (1) The process of raising the standards of living of wage earners necessarily involves increasing the ratio between wage rates and prices; and (2) an increase of wage rates relatively to prices depends fundamentally upon increasing the efficiency of production. The second principle, he said, is commonly overlooked. Attention has been concentrated upon increasing the flow of money income, first, by reducing the number of hours worked and thereby increasing the number employed; and, second, by raising the rates per hour. Little thought, he claimed, has been given to the increase in productive efficiency and productive output which alone make higher real wages possible.

Coming finally to the problem of readjustment, in connection with which he discussed the effect of inventories in the present situation, Dr. Moulton said that some reductions in wages, coupled with further increases in efficiency, appear indispensable to an expansion of production in some of the more important fields where these maladjustments have occurred, such as housing, where high wage rates defeat labor's objective of a high annual income. In other lines, such as public utilities, the wage cost factor is apparently not of such decisive importance. In general, he added, expansion in the field of capital enterprise, involving long-term commitments, awaits the re-establishment of confidence with respect to the future of the capitalistic system.

Jubilee

On Feb. 3, 1938, in New York City, the Engineers' Club celebrated its fiftieth anniversary at a dinner in the club house at which about 200 members were present. Byron Eldred, newly elected president of the club, presided and reviewed the club's history. Several original members were introduced amid applause. Past-Presidents Barnes, Fogg, McKay, Gardner, and Tuttle spoke briefly, and F. L. Carlisle, of the Consolidated Edison Company, gave the address of the evening.

"Breck"

Hundreds of mechanical-engineering graduates of Lehigh, Michigan State, Illinois, and Yale will be glad to learn through the testimony of the accompanying photograph, taken in Italy within a few weeks, that Prof. and Mrs. L. P. Breckenridge are well and happy in body and mind. Although the photograph does not show the landscape of the environs of Sorrento, in others received in the same post, snow-capped Vesuvius appears beyond the iron railing of the same terrace, and the same folding chairs are in the foreground. The letter is as typical as the photograph, for it proposes another job for engineers. Former associates of Professor Breckenridge will recall that on those infrequent occasions when he was detained at home with a cold he would think up, in a few hours, more things to do than they could accomplish in as many years.

Since October "The Brecks" have been in Italy, their winter "home" for nearly half the years since 1923. Breck confessed some years ago that they could speak "verbless" Italian. "I decline Italian," he said, "and Mrs. Breckenridge, who reads Italian novels and newspapers, conjugates it. I can do three

things in Italian: I can order food, count money, and be polite!" After all, that is more than many of us can do in our native tongue.

Summers are spent in Vermont, in the sturdy little house on the western slope of Mt. Philo, overlooking Lake Champlain, with the Adirondacks in the distance. Behind the house the chipmunks live in the bank. "Mr. Wall Street," the accomplished rodent who has learned all manner of polite accomplishments from the great teacher and his wife, harvests every summer a store of peanuts from Breck's pocket, hat, and numerous other places of concealment. The peanuts are always in their shells, because Breck believes that even chipmunks should work for their living.

"THE BRECKS"—SORRENTO, ITALY, DECEMBER, 1937

The Brecks employed the early years of their leisure collecting ferns. After samples of every variety ever found in Vermont, and some that had never been noted there before, had been properly mounted, the entire collection was given to the University of Vermont and native orchids became the object of summer searches. Photography is practiced wherever they go. A photograph of a class of Italian school children served a distraught teacher as a reward for good behavior throughout an entire winter. The ubiquitous cane comes into use in photographing wild flowers in their native haunts. Placing the camera a cane's length from the object to be photographed insures perfect focus.

An uphill fight to save the few remaining covered bridges spared by the destructive floods of Vermont some years ago, stimulating conversation and homely advice, and the affairs of "Breck's International Heavenly Blue Morning Glory Club" afford occupation wherever he travels from California to Italy. The pioneer in the smokeless burning of Illinois coal even turned his attention to the problems of California orchardists during last winter's cold season, when so much damage was done by smudge pots. It is reported that the affairs of the BIHBMGC have been closed up, officially, because the heavenly blue morning glory, imported by Breck from Italy, is now in bloom somewhere in the world every day in the year from seeds distributed by this lover of beauty to friends and chance companions on ship and train. Even the London *Times* carried a story about it some years ago when the large blue blossoms were discovered in a London window box belonging to one of Britain's most famous actresses. And New York dealers now carry the seeds.

So the kindly influence of Breck continues to spread throughout the world, while his "boys" carry on the more technical phases of the training he gave them.

Cooper

At Boston, Mass., Feb. 2, 1938, Dexter Parshall Cooper, hydraulic engineer, popularly known as "father of Quoddy," died of a heart attack at the age of 57.

Son of a bridge builder who turned hydraulic engineer, and long associated with his widely known brother, the late Hugh L. Cooper, Dexter Cooper had been connected with some of the largest hydroelectric projects of this generation, chief of which were the Keokuk plant on the Mississippi River, and the Wilson Dam for the Muscle Shoals power project in Alabama.

From a summer home on Campobello Island, at the mouth of the Bay of Fundy and Passamaquoddy Bay, he watched the enormous ebb and flow of tides and devised a heroic plan to harness the energy represented in the rush of the waters into and out of the ocean. In 1926 the Federal Power Commission issued a permit for his tidal-power project, designed to utilize two pools, and thus involving also a franchise granted by the Canadian government, and estimated by Mr. Cooper to cost about $100,000,000. Interest in the scheme kept Mr. Cooper in this country while his brother Hugh was abroad engaged in building the Dnieprostroy dam for the Soviet government. His would be the first large-scale tidal-power plant.

But Dexter Cooper was destined to die a disappointed man whose ambitious project ran afoul of political and economic difficulties. Heeding protests of the fishing interests, the Canadian government withdrew its franchise, and the plan was modified to a single-pool scheme located entirely within the United States. The story of the attempted development by the United States in 1935 is too well known to be repeated. Controversy over this cause célèbre rocked the country and the Congress, and resulted in abandonment of the project, and of $2,000,000 "Quoddy City," built in anticipation of the engineering construction that had been started.

No one doubts that Dexter Cooper could have made the moon and the Quoddy tides serve his will. It was the tides of economics and human emotions that he could not control.

Swedenborg

The earlier and later periods in the life of Emanuel Swedenborg, whose birth occurred two hundred and fifty years ago on January 29, 1688, are so dissimilar that many persons who think of the Swedish savant as a mystic whose speculations in the realm of the metaphysical gave rise to a religious sect are surprised to learn that as a young man his contributions to science, technology, and finance placed him in the front rank of men whose knowledge was of that universal character possessed by Aristotle, da Vinci, Bacon, and Newton. Engineers can afford unreservedly to acclaim the importance of the first phase, at least, of his career.

In the February, 1938, issue of the *Scientific Monthly*, John R. Swanton, of the Smithsonian Institution, presents a summary of some of Swedenborg's mundane accomplishments. Says Dr. Swanton: "In Sweden he had already acquired the art of bookbinding and made shift to play the cathedral organ. In London he added in this way some knowledge of watch making, cabinet making, and the making of mathematical instruments. Later, in Holland, he learned how to grind lenses for microscopes. But he devoted most of his time to mathematics and astronomy. . . . . . His mind was also busy with attempted inventions . . . . . a submarine, a hydraulic engine, a new type of lock, a fire engine, a machine gun, a mechanical musical instrument, a mercury air pump, and an airship."

Speaking of certain engineering achievements, Dr. Swanton continues, "the most striking of these was the transportation overland . . . . . a distance of 14 miles, of two galleys, five large boats, and one sloop . . . . . He was engaged similarly in the construction of the great dock at Carlscrona and on the North Sea Baltic canal. . . . . . "

In much of his writing Swedenborg drew on the work of others "with the deliberate intention of correcting any ten-

dency toward personal bias in the interpretation of organic phenomenon." His work is said to be prophetic of the science of stereochemistry; and Dr. Swanton quotes Svante Arrhenius concerning him as follows:

If we briefly summarize the ideas, which were first given expression to by Swedenborg, and afterwards, although usually in a much modified form—consciously or unconsciously—taken up by other authors in cosmology, we find them to be the following:

The planets in our solar system originate from the solar matter—taken up by Buffon, Kant, Laplace, and others.

The earth—and the other planets—have gradually removed themselves from the sun and received a gradually lengthened time of revolution—a view expressed by G. H. Darwin.

The earth's time of rotation, that is to say, the day's length, has been gradually increased—a view again expressed by G. H. Darwin.

The suns are arranged around the Milky Way—taken up by Wright, Kant, and Lambert.

There are still greater systems, in which the Milky Ways are arranged—taken up by Lambert.

His studies and writings on the human brain were well in advance of his time. He made "proposals for increasing the yield of copper from ore, for improvements in the manufacture of steel" . . . . . and "expressed a belief, contrary to the accepted practice of the time that 'there ought to be no secrets at all in metallurgy.'" In 1760 he wrote several memorials on the currency.

Swedenborg was more than fifty years of age when his studies and writings on physical subjects gave way to those in theology, which he carried on up to the time of his death, in 1772. Emerson, in his "Representative Men," writes of Swedenborg as the mystic. "His profound mind," says the American philosopher, "admitted the perilous opinion, ... that he was an abnormal person, to whom was granted the privilege of conversing with angels and spirits. . . . ."

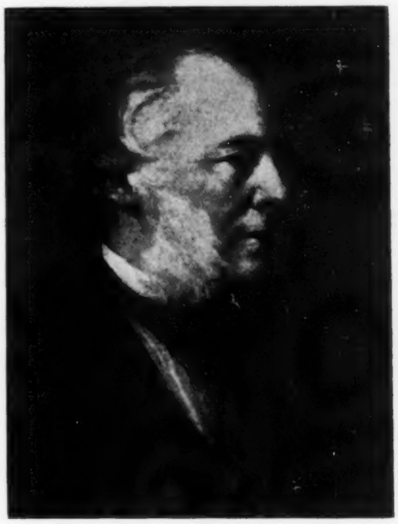
Swedenborg's writings thus assumed an apocalyptic character. "These books should be used with caution," says Emerson; and Kant, whose views were less charitable and even contemptuous, expressed a similar opinion.

It is not easy to understand the complete break in Swedenborg's intellectual life, but Emerson's final summing up may contain a clue; he says:

Swedenborg has rendered a double service to mankind . . . . By the science of experiment and use, he made his first steps: he observed and published the laws of nature; and ascending by just degrees from events to their summits and causes, he was fired with piety at the harmonies he felt, and abandoned himself to his joy and worship. This was his first service. If the glory was too bright for his eyes to bear, if he staggered under the trance of delight, the more excellent is the spectacle he saw, the realities of being which beam and blaze through him, and which no infirmities of the prophet are suffered to obscure; and he renders a second passive service to men, not less than the first, perhaps, in the great circle of being, and, in the retributions of spiritual nature, not less glorious or less beautiful to himself."

Smiles

At the Zion School, Leeds, England, on Dec. 4, 1937, a memorial to Samuel Smiles, M.D., LL.D., author of "Self-Help," "Lives of the Engineers," and world-famous books on engineering biography, was unveiled by Sir James Baillie, vice-chancellor of the University of Leeds. Dr. Smiles was a contemporary of many engineers who laid the foundations of the era of machine production that had been initiated in the industrial revolution and given forceful direction by the introduction of the steam engine. Although a surgeon by training and vocation he is best known for his biographical writings and his services to education. His books, with the first dates of publication by John Murray are: Life of George Stephenson, 1857; Self-Help, 1859; Lives of the Engineers, 1861; Industrial Biography, 1863; The Hugenots, 1867; Character, 1871; Boy's Voyage Round the World, 1871; Thrift, 1875; Scotch Naturalist, 1876; Robert Dick, 1878; Duty, 1880; Jasmine, 1891; Josiah Wedgwood, 1894; and Autobiography, 1905.



SAMUEL SMILES

At the unveiling, H. W. Dickinson, honorary secretary of the Newcomen Society, said: "It is fairly clear to me that unless someone like Dr. Smiles, with the literary ability, acumen, and synthetic mind, had undertaken the task of engineering biography, the world would have been much poorer. Indeed it is probable that but for Smiles this task would not have been undertaken."

The inscription on the memorial tablet reads: "This tablet commemorates Samuel Smiles, M.D., LL.D. Born Haddington 1812. Died Kensington 1904. Editor of the *Leeds Times* 1838–42 and surgeon at Springfield House, Holbeck, 1842–45. Twenty-one years secretary of the Leeds & Thirsk Railway & The South Eastern Railway. His best-known book 'Self Help,' which developed from lectures that he gave in Leeds, has been printed in twenty-six languages. 'Lives of the Engineers' and other biographical books recorded the creative work of industrial pioneers and self-taught men of genius of humble origin. His advocacy of national education, free public libraries, and other social and Parliamentary reforms, materially influenced public opinion in the West Riding. For several years from 1841, he gave his services as a teacher at Zion School. Erected by public subscription 1937."

Brigman

At Louisville, Ky., on Feb. 8, 1938, Bennett Mattingly Brigman, dean, Speed Scientific School, University of Louisville, and vice-president, The American Society of Mechanical Engineers, died at the age of 56 of a heart ailment. He had entered the hospital for treatment on January 10.

Dean Brigman was born at Louisville on Feb. 25, 1881, was educated in the schools of that city, received the degrees of B.S. in 1908 and of M.S. in 1912 from the University of Louisville, and, with the exception of summers from 1906 to 1915 which were spent in industrial and engineering practice, his life work was carried on in his native city. From 1902 to 1904 he served as acting engineer of tests of the Louisville and Nashville Railway Co., at Louisville, Ky., representing the company in the trials for the purchase of machinery and equipment for the then new South Louisville shops. His teaching career began in 1904, with instruction in manual arts at the University School (preparatory). For nine years, from 1907 to 1916, he was instructor in manual arts at the du Pont Manual Training School, Louisville. During the last four years of

B. M. BRIGMAN

this period he served as part-time instructor in drawing at the University of Louisville. In 1916 he became assistant professor of drawing and physics at the university, and in 1919 professor of engineering and drawing.

It was during the years from 1916 to 1923 that Dean Brigman engaged in private consulting work in patents and machine design. Called upon in 1923 to organize a school of engineering at the University of Louisville, he became, in 1924, dean of engineering, and, with this added burden, relinquished his private practice to devote his energies to the school.

Dean Brigman was elected a member of The American Society of Mechanical Engineers in 1923 and a fellow in 1936. He served as a manager from 1934 to 1937, when he was elected vice-president. He is also a member of the Society for the Promotion of Engineering Education, American Association for the Advancement of Science, American Society for Testing Materials, and American Institute of Electrical Engineers. In 1933 and 1934, he was vice-president of the Society for the Promotion of Engineering Education, and, at his death, represented that body and The American Society of Mechanical Engineers on the Engineers' Council for Professional Development Delegatory Committee of Group IV. He was a member of American Institute of Electrical Engineers' Committee on the Engineering Profession in 1930 and 1931 and had been a member of its Committee on Legislation Affecting the Engineering Profession since 1931. During the World War, he was in charge of the speakers' bureau, Council of National Defense, and the Bureau of War Savings Stamps for Kentucky. Other civic activities included membership on the Planning and Zoning Commission of the City of Louisville and chairman of the Smoke Abatement League of Louisville. He was active in combating the effects of the flood at Louisville in 1937.

Of slight physique and forced to nurse a heart not strong enough for the energy and enthusiasm of his active mind, Dean Brigman possessed talents that brought his services into demand by his native city, and by professional and engineering societies with which he was associated. He expressed his views with a directness and conviction that won for him the respect of engineers and educators throughout the country. There was a friendliness and charm about his personality that won and maintained close friendships. He was in regular attendance at meetings of the A.S.M.E. and the S.P.E.E., where he and Mrs. Brigman were generally the center of a warmly admiring group. Outside his native city there will be few who will miss him as greatly as will that group of teachers of mechanical engineering that learned to think of him in terms of respect and affection during the weeks spent at the summer school held by the S.P.E.E. at Purdue in 1929.

Steam-Turbine Locomotives

RAILWAY MECHANICAL ENGINEER

SUPPLEMENTING the brief item about a steam-turbine locomotive reported in this section in the November, 1937, issue, this and other locomotives of the same type are discussed in a report of the Committee on Steam Turbines and Steam Condensing Locomotives of the Railway Fuel and Traveling Engineers' Association, presented by Loren P. Michael, member A.S.M.E., and chairman of the committee, at the annual convention of the association in Chicago, Sept. 28 to Oct. 1, 1937. The report appears in *Railway Mechanical Engineer* for November, 1937, from which the following is taken.

From latest reports, three steam-turbine locomotives are being operated in Sweden and one in England. They were all built under the Ljungström patents and are of the noncondensing type. The general design is practically the same as for the standard reciprocating locomotives in the countries in which they are being used except that the steam cylinders are replaced by a steam turbine having its shaft at right angles to the longitudinal center line of the locomotive. This turbine shaft is fitted with a pinion which drives, either directly or through an intermediate gear, a main gear on a jackshaft which extends across the front of the locomotive, and is under the smokebox.

The direct drive (pinion to main gear) drives the locomotive in one direction, and the drive from the pinion through the intermediate gear to the main gear drives the locomotive in the opposite direction. Disks are located on the ends of the jackshaft and are spaced laterally the same distance apart as the driving wheels on the locomotive. Crankpins are located on the outside faces of these disks and carry the front ends of the main rods which extend backward to the main crankpins on the driving wheels in the usual manner. The service obtained from these locomotives has been reported as being satisfactory, and in Sweden more of them, of practically the same design, will be built in the near future.

Commenting on the Union Pacific steam-turbine electric locomotive, being constructed at the Erie works of the General Electric Company, which members of the A.S.M.E. in attendance at the National Fall Meeting of the Society were able to inspect, Mr. Michael remarked that it is to be completed and ready for test and regular service in the near future. This locomotive is being built in two units, each to be 90 ft. 10 in. long and to weigh 530,000 lb, or a total of 1,060,000 lb for the complete locomotive. Each unit is to be of the 4-6-6-4 type with 2500 hp capacity, making a total of 5000 hp for the locomotive.

Each unit is to have a 1250-lb automatic boiler of the steamotive type described in MECHANICAL ENGINEERING, December, 1936, burning bunker C fuel oil to furnish high-temperature steam to a compound steam turbine which will be geared to an electric generator which will in turn furnish electric current to six motors on the six pairs of driving wheels. Air-cooled steam condensers are to be used to condense all steam exhausted from the main turbine and also from the small turbines used to drive the auxiliaries. Each unit will have a starting tractive power of 80,000 lb, making a total of 160,000 lb for the locomotive.

In the interest of fuel economy and an effort to develop motive-power units having better operating characteristics, less over-all length and weight, lower first cost as well as lower operating and maintenance costs, and a far greater availability for service, the committee has been investigating, since 1928, the possibilities of steam-turbine locomotives. After having determined the advantages of such a locomotive, the committee, in cooperation with 17 manufacturers, is said to have developed a practical and satisfactory design for a steam-turbine locomotive with a suitable mechanical transmission to the driving wheels.

The locomotive is to be moderately streamlined, 84 ft long over couplers, to weigh 500,000 lb when ready for service, have 64,000 lb starting tractive power, develop 4000 hp on slightly

less than 9 lb of steam per hp-hr, and condense all of this steam, including that from the auxiliary turbines, and use it again as boiler feedwater. The boiler is to deliver steam at 1200 lb pressure and 850 F temperature to the steam turbine.

Four cylindrical, continuous-tube, high-pressure boilers will be used, two located near each end of the locomotive cab. Full-automatic controls will be provided for the oil burner, boiler feed pump, and combustion-air supply to maintain practically constant pressure and temperature at highest efficiency. The gases of combustion are to pass through the evaporator coils, superheater, and preheater section of the boiler tubes and then through a combustion-air heater before passing out of the stack. An efficiency of 85 per cent should be obtained with this arrangement.

The main steam turbine is to be of the impulse-reaction type designed for a speed of 8000 rpm at 120 mph. The bladed portion of the turbine consists of two 24-in. mean diameter Curtis wheels in series followed by 18 stages of reaction blading. The transmission of power from the steam turbine is to be through a reducing gear from about 6700 to 1800 rpm at 100 mph to a driving shaft and through a hydraulic coupling, epicyclic traction increasing gear at low speeds (which, however, will be inoperative at higher speeds), then through a reversing gear to a shaft driving a hypoid pinion and gear and each driving axle.

The locomotive is designed to be operated at 110 mph at equal speed and tractive power in either direction. The efficiency of the direct-drive gearing from steam turbine to the rail at the driving wheels is expected to be over 90 per cent, or about 15 per cent higher than for electric transmission used with Diesel-powered or with steam-turbine-powered locomotives.

Coal: The Next Step

THE INSTITUTE OF FUELS

HAVING been elected president of the Institute of Fuels for the second year, Sir Philip Dawson, in his second presidential address before the members on Oct. 14, 1937, discussed the problem of the fuel resources of England on the broadest possible lines, namely, on what had been done, what was being done, and what could be done to utilize this national asset to the fullest possible measure. Briefly outlining the work of various government commissions and committees made in 1905, 1917, and 1926, Sir Philip considered the progress made since 1926 together with the new developments and inventions which have evolved since that time.

The coal obtained by machine cutting has risen from approximately 20 million tons in 1910, to 104 million tons in 1934. Of course, more of the "dirt" is brought to the surface, but improvements in cleaning have more than counterbalanced this effect. Technically, it is possible to supply coal of any desired quality; but unfortunately this cannot always be obtained by the consumer, owing to the operation of the "quota" regulations. Considerable attention has been paid by industrial organizations to the question of coal sizes and nomenclature. Small coal now commands a much higher price than could be obtained 10 or 15 years ago. In some cases large coal has to be deliberately broken down.

Among the users of coal is the gas industry which has changed from a purveyor of light to one of heat. The gas-manufacturing process now attains an over-all thermal efficiency of well over 80 per cent. Production of gas is governed by the Gas Regulation Acts of 1920 and 1929. However, the industry has met all requirements and has even gone beyond them by introducing additional refinements in the purification of gas, including the removal of organic sulphur compounds incidental to the recovery of benzol and other by-products.

In the coke industry, by-products are recovered from over 98 per cent of all the coal carbonized. Blending has been systematized, and savings have been effected in certain districts by finding markets for surplus gas. Attempts to produce synthetic products from coke-oven gas, such as alcohol, have so far only met with limited success. The iron and steel industry has been another great user of coal and coke. But even here, the "quota" regulations have made it difficult to obtain uniformity of size as well as uniformity of chemical and physical characteristics. Assisted by a tariff arrangement of the government, Imperial Chemical Industries, Ltd., proceeded to build a large-scale hydrogenation plant at Billingham to provide a supply of oil from coal. Up to the present time, the results obtained in this plant have not been disclosed; but it is understood that the technical results anticipated have been achieved. The use of pulverized fuels for land purposes has proceeded on normal lines, and its value is fully recognized. A little progress has been made in the development of an oil-coal mixture for use under furnaces.

In commenting on activities in other countries, Sir Philip stated that within another three years Germany will cover the entire demands of motor fuel and oil from home-produced materials. In the United States the future development of coal depends in large measure on the extent of the supply of petroleum, natural gas, and water power. Present coal research there is directed mainly toward further economy and convenience in utilization; but since the proved petroleum reserves are estimated to last a much shorter time than the coal deposits, it is obvious that in the next few years coal will not only recover its place as the main source of power and heat, but also must become the raw material for the production of liquid and gaseous fuels. It is apparent that the fuel policies of the great industrial countries will eventually have to follow the same general lines, namely, preparation for the production of oil from coal and the coordination of the use of coal and oil.

Coal being the British nation's greatest indigenous asset, steps should be taken at once to insure the government's being in a position to direct to a great extent a national policy on coal utilization from the point of view of national economy. In other words, eliminate a large amount of the present unnecessary waste; for instance, the use of high-class coking coals for domestic purposes. Linked up with plants built for carbonization of coals should be central installations for treating the by-products. Based on the country's requirements of the chemical products obtainable, a comprehensive production plan should be worked out, so that a situation is not developed which would cause overproduction of any one commodity and lead to depressed markets. Utilization of by-products should be considered in conjunction with the production of motor fuels by such processes as hydrogenation and liquid-fuel synthesis from coal.

In the light of present-day experience it is clear that there can be only one centralizing authority, and that is the government. This does not mean government control, but a central body to collect and analyze all the available experience and knowledge and to define the most suitable policy for development in the national interest. It must be made clear at this point that the proposals made are for a body which shall be advisory only, without executive power other than that essential for the collection of the necessary information. Let us remember that we are at the beginning of a new era which is to treat coal as the raw material of a manufacturing process, and

the mapping of the road upon which this new era is to travel is a matter of the greatest national importance, calling for the advice of the highest authorities in each section of the industry. Only by one supreme central body can guidance be given which will place the nation on the road which will provide the greatest benefit for all sections of the country.

Metal Coloring

AMERICAN SOCIETY FOR METALS

IN SO FAR as systematic research in the coloring of metals and alloys by chemical and electrochemical processes is concerned, according to C. B. F. Young, in a paper presented to the American Society for Metals at its convention in October, 1937, very little has been done and much remains to be discovered. However, certain methods that have been used successfully are briefly described. Hard, durable, and fast colors, in some cases resistant to corrosion, can be applied. The author presents data on chemical solutions for coloring aluminum, brass, cadmium, chromium, copper, iron, magnesium, silver, tin, and zinc, and describes electrochemical processes for coloring aluminum, chromium, magnesium, nickel, cobalt, and tin.

Aluminum, says Mr. Young, may be given a dead-white coating or colored black, and may be colored any hue of the rainbow by first producing an oxide coating on the surface and then allowing this to absorb and react with organic dyes, forming insoluble lakes. The colored compounds thus formed are integral parts of the metal. Oxide coatings can be produced on aluminum by making this metal the anode in a suitable solution. The three commercially important solutions are the sulphate, the chromic-acid, and the oxalic-acid methods. The first method produces coatings most suitable for coloring as the film produced is practically colorless, transparent, and hard. The second process produces a slight grayish tinge, somewhat opaque. The third produces finishes with a slight yellow tinge, almost transparent. From the standpoint of coloring, the sulphate solutions are more desirable than the other two, as the chemicals used are cheap and nonpoisonous, and the process is completed in about 15 min.

Formulas are given for coloring copper and brass black, brown, blue, and green.

Chemical coloring of iron and steel parts, says Mr. Young, is gaining ground. The coatings produced not only are attractive but also serve as protection against corrosion. Black can be produced by immersion in a solution given for a period of 20 to 30 min.

An alloy deposit consisting of cobalt and nickel is proving to be of commercial importance as the coating produced is whiter than nickel and has better corrosion-resistance properties. The color is said to approach that of pure silver.

A method is given whereby an ebony deposit is attainable on zinc. Other colors which may be coated on zinc are dark brown, rich brown, steel blue, and bright purple. A solution is given whereby yellow, brown, crimson, blue, purple, and light green may be produced in succession on zinc, and another which produces iridescent sequences of colors.

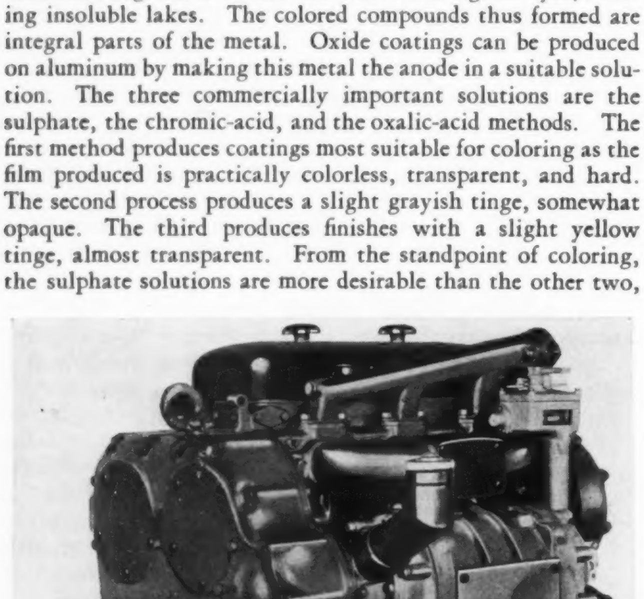


FIG. 1 MODEL 3-71, TWO-CYCLE DIESEL ENGINE

Mass Production of Diesels

GENERAL MOTORS CORPORATION

CULMINATING ten years of research and development by engineers of General Motors Corporation under the direction and supervision of Charles F. Kettering, vice-president in charge of research, and member, A.S.M.E., the corporation announced on Jan. 19, 1938, the opening of a compact, highly efficient plant in Detroit designed exclusively for the manufacture on a mass-production basis of high-speed Diesel engines of from 22 to 160 hp and comprising from one to six cylinders. A schedule of 50 engines per eight-hour day has been planned.

The keynote of the manufacturing program is precision of an order which requires standards even more exacting than the high requirements of the mass-production automobile industry. In effect, the individual skills of the finest instrument makers have been mechanized so as to produce interchangeable and reproducible parts on a mass-production basis within tolerances to which no hand skill can ever aspire. In producing piston and connecting-rod assemblies, each of the parts is interchangeable as to size and weight with its fellows and each assembly is made to conform to the same weight specification by the use of ingenious machines which automatically weigh the piston or the rod, and machine it precisely to the weight required.

In the department where fuel injectors are built, the maximum clearance between the barrel or bore of the injector which moves within it must not exceed 50 millionths of an inch. The general run of the limits on all parts of the injector, apart from those already mentioned, is of the order of one ten thousandth of an inch. The electric instrument used to measure these parts is accurate to the millionth part of an inch and gives an exact reading on a large calibrated scale.

Adjoining the plant is a large and completely equipped Diesel-engine test laboratory according to the announcement. Here in the plant and the laboratory, the engineering department will design the Diesel engines for all divisions of the corporation and the personnel in the laboratory will carry on the test work for the entire group. Other Diesel-engine plants are located in Cleveland where a full line of medium-size engines ranging from 200 to 600 hp and "packaged-power" units, consisting of the small-model Diesel engines and generators, in either stationary or portable models, will be produced; and in La Grange, Ill., where a new engine factory of the company's

Electro-Motive Corporation's Diesel-locomotive plant will be in operation within a few months for the manufacture of engines of from 600 to 1200 hp.

Designed to use ordinary furnace fuel oil, the two-cycle Diesel engines to be manufactured at the Detroit plant will include one-, three-, four-, and six-cylinder models, rated from 22 to 160 hp max at 1800 rpm. In construction and appearance, they will be similar to conventional four-cycle gasoline and Diesel engines. The cylinders are cast en bloc with removable dry liners. The cylinder head is a one-piece removable unit with overhead valves which are operated through rocker arms and push rods from a camshaft located in the upper part of the cylinder block and driven by a train of gears which also drive the blower. The water pump, fuel-transfer pump, and governor are mounted on the blower and driven by it. Oil pan and valve covers are one-piece pressed-steel units.

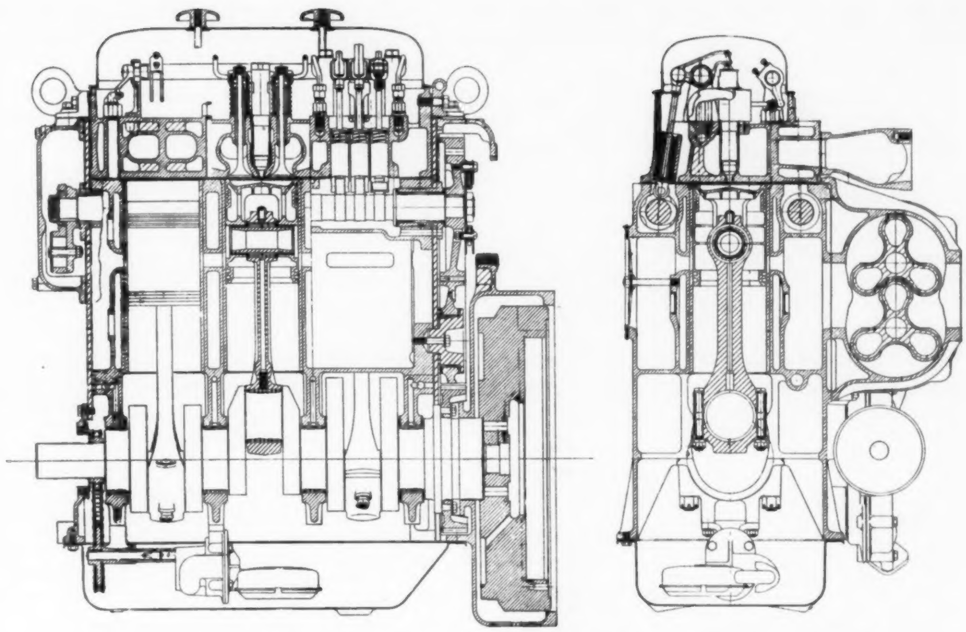


FIG. 2 LONGITUDINAL AND LATERAL CROSS SECTION OF TWO-CYCLE DIESEL ENGINE

The only really new design feature of the engine is the provision for completely balancing the engine. With the camshaft arranged to give uniform firing of all cylinders at each revolution, there results a small fore-and-aft rocking couple. This has been balanced out by small counterweights at each end of the camshaft, and a second similar shaft on the other side of the cylinder block.

As will be seen from a casual inspection of the engines, the cylinders are the same size for all models in the series, one, three, four, and six. The front end of the cylinder block of all models is exactly like the rear end, and in a similar manner the cylinder head, blower, bearings, etc., are all alike on each end. The pistons, valve gear, connecting rods, bearings, pumps, timing gears, flywheel housings, and like parts are the same for all models and completely interchangeable. The dimensions of all cylinder blocks and heads, crankshafts, camshafts, blowers, etc. are identical for all sizes in everything except length.

But perhaps the most interesting feature is that the entire cylinder-block and blower assembly can be turned end for end without disturbing the flywheel or gear train, and thus change all the accessories to the opposite side. In a similar manner, the cylinder head can be reversed, regardless of the position of the blower, and the exhaust and water manifolds can be placed on either the opposite side or the same side as the blower. By shifting one gear in the gear train and changing the camshaft and oil-pump cover, the rotation of the crankshaft can be made either clockwise or counterclockwise with any of the accessory arrangements. Since all these assemblies can be made with but a few right- and left-hand parts, it results in eight distinct models of each engine size.

In Fig. 1 is shown the three-cylinder engine in the 71 series. Fig. 2 shows a longitudinal and a lateral cross section, respectively, of the same engine. The general specifications for this engine are given in Table 1.

TABLE 1

Number of cylinders	3
Bore and stroke, in	4.25 × 5
Total displacement, cu in	212.69
Maximum output at 1800 rpm, hp	80
Continuous rating at 1200 rpm, hp	45
Continuous hp rating bmep; lb per sq in	70
Maximum torque, at 800–1000 rpm, lb-ft	283
Compression ratio	16:1
Piston speed, at 1200 rpm, fpm	1000
Weight of basic engine (dry), includes starting motor, governor, oil cooler, oil filter, and fuel filter, lb	1160
Fuel consumption, lb per bhp-hr	0.45
Lubricating-oil system, qt	8.5
Fuel-oil tank, gal	30
Cooling water, gal	11

Flexible Mounting of Diesels

A.S.M.E. FALL MEETING AT ERIE

MOUNTING the power plant crosswise at the rear of a passenger bus, in conjunction with an electrical transmission, provides maximum passenger capacity but at the same time brings up problems of noise and vibration. In his paper on "Flexible Mounting of Diesel Engines for Transportation Service," presented at the Fall Meeting of The American Society of Mechanical Engineers at Erie, Pa., October 4–6, 1937, H. W. Gouldthorpe, engineer, General Electric Company, describes a method of solving these problems.

In the development of a suitable Diesel-electric-drive arrangement, the conventional flywheel was eliminated. To do this, it was necessary to design a coupling member to support the engine end of the armature so that it would have rigidity torsionally for the engine and radially for the maintenance of the electrical air gap, but which, at the same time, would have flexibility in angular and axial directions to compensate for assembly and machining characteristics. Other duties of the flywheel, such as engine timing and cranking, have been taken care of on the generator fan.

Having linked the armature to the crankshaft in such a manner that it could be used as a flywheel, it also appeared desirable to locate the stator structure with respect to the engine

block so that the entire assembly could be supported as a single mass unit. This was accomplished by making a bellhousing to serve the dual purpose of frame support and generator fan outlet. This union of engine and generator in a single stationary structure results in a member which lends itself to ideal flexible supporting and which does not require great accuracy of location in the chassis supporting members.

In addition, with the engine and generator frames rigidly attached, the system is in equilibrium torsionally in so far as the static load is concerned and the chassis need only carry inertia torque and gravitational load. The vertical impacts can be further cushioned and limited by proper choice of flexible supports.

Since this construction results in a power-plant unit which is complete in itself and has no power connections with the vehicle other than a pair of flexible cables it is possible to apply actu-

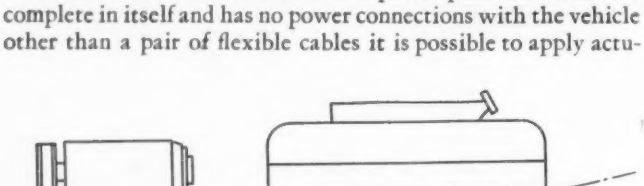


FIG. 3 ARRANGEMENT OF DIESEL ENGINE AND GENERATOR FOR MOUNTING AT REAR OF BUS SHOWING LOCATION OF PRINCIPAL MASS AXIS

ally a theoretically ideal mounting. Such a mounting should be designed so that a predetermined limited amount of energy is transferred to the vehicle. Since the greater part of the disturbance appears as crankshaft torque, the best condition will be obtained where a high degree of freedom is permitted about the principal mass axis. The mounting plane should be chosen then in such a manner as to contain this axis. In the actual power plant the principal mass axis can be found by calculation and in most cases will be displaced from the crankshaft axis by a considerable angle in the vertical plane as shown in Fig. 3. In rear-engine busses the cylinder block is usually inclined to conserve space, which also affects the location of the principal mass axis of the system horizontally.

The location of this axis will also be affected by the accessory group which is carried by both the engine and generator. In order to simplify the installation and be certain that the load is equally divided without undue adjustment, three points of support in a plane containing this axis are preferable. One high support can be used at the front end of the engine and two others at lower points opposite the generator. There is some latitude in axial location of the rear supports in so far as the action of the unit on its mounting is concerned and for this reason their location should be chosen so as to favor the power-plant structure as much as possible. From the standpoint of strength in bending, the bolted connection between the bellhousing and engine block is limiting. The rear supports are, therefore, located at such a position that zero bending occurs in this plane. Sufficient bolts and dowels need only be used to withstand vertical shear forces and torque.

A certain amount of snubbing is desirable for a mounting of this type in that the maximum movement of the power plant can be limited without sacrifice of flexibility at the low idling speed of the engine. By limiting the maximum movement exhaust pipes, fuel lines, and radiator connections are simplified in construction and are less susceptible to damage from excessive vibration and road shock. Mountings having a variable deflection rate also tend to reduce peak forces caused by impact and, therefore, reduce the duty on the supporting structure.

Noise Measurement Units

INDUSTRIAL STANDARDIZATION

BEFORE noise can be measured at all, a unit must be chosen to express the physical intensity of a sound and the loudness with which a person's ear hears it. As a result of a conference held under the auspices of the International Standards Association at Paris in July, 1937, according to an article by Harvey Fletcher, physical research director, Bell Telephone Laboratories, in the January, 1938, issue of *Industrial Standardization*, the unit to be used for intensity-level measurements will be the decibel, but the unit to be used for loudness-level measurements will be the phon. This international agreement will now make it possible to compare the results of noise measurements carried out in different countries.

The reference sound and the scale for sound-level measurement are characterized as follows:

(1) The reference sound is to be produced by a plane, sinusoidal, traveling wave with a frequency of 1000 cycles per second.

(2) The reference sound shall correspond in round numbers either to an intensity of 10^{-16} watts per square centimeter or to an acoustical pressure of 2×10^{-4} baryes (dynes per square centimeter).

(3) In each case the intensity scale or the pressure scale is to be graduated in decibels with respect to the reference level.

Loudness measurements are to be made by listening to the reference sound and the sound to be measured, alternately, with both ears, while the intensity of the reference sound is regulated until an ordinary observer considers that it has the same loudness as the measured sound. Whenever possible the reference sound and the one measured should be listened to for practically the same length of time. This period should never be shorter than one second when listening to the reference sound.

When, under these conditions, the intensity level or the pressure level of the reference sound (the pressure being that of the free wave before the operator's head is in the acoustical field) is *n* decibels above the reference zero, it is said that the sound measured has a loudness level of *n* phons.

Primary loudness measurements are made in a sound-deadened room or outdoors where there is no reflected sound. The intensity of the reference tone, which is generally generated with an oscillator and loud speaker, is usually measured with a calibrated condenser microphone.

Bearings From Powder

METALS AND ALLOYS

BRINGING out the advantages of copper-lead bearings in modern internal-combustion engines, Erich Fetz, research metallurgist, in a report in *Metals and Alloys* for September, 1937, tells of his research work in successfully preparing alloys for bearings with a content of more than 30 per cent lead from metal powders. Inasmuch as many of the objections to copper-lead had arisen from difficulties associated directly with pour-

ing and solidifying this type of bearing, preparation of copper-lead bearings by powder metallurgy appeared to be the solution to the problem.

At first various spraying tests were conducted but were abandoned since another way led directly to the proper method, namely, pressing of copper-coated lead powders into strips, sintering in a hydrogen or neutral atmosphere, and bonding onto a metallic carrier. Copper-lead bearings so prepared, and containing 20–35 per cent lead, can be heated to 900 C without lead sweat; a mixture containing 45–55 per cent lead can be heated to 750 C. At these elevated temperatures, adhesion forces come into play, and interaction by diffusion of atoms readily takes place. Thus a well-sintered metallic body, quite susceptible to bending and cold rolling, is secured.

In order to bond these copper-lead strips to a backing sheet, an intermediate layer of tin was used. This was done by dipping the latter into liquid tin, using as flux a zinc-ammonia solution, and then pressing the copper-lead strip onto the backing. The strength of the bearing formed in this way can be further improved by heat-treatment.

Composite bearings were also made consisting of a pure copper-powder bottom and a copper-coated lead-powder surface. Both powders were pressed simultaneously in the hydraulic press, sintered at temperatures higher than 700 C, and slightly cold-rolled to eliminate warping and shrinkage effects. The following advantages are possessed by these duplex bearings:

(1) The production costs of the powder bearings are much reduced, as only the bearing surface consists of the most expensive part, the copper-lead powder.

(2) The heat dissipation is improved by using a solid-copper bottom layer.

(3) The strength of the bearing is greatly increased.

(4) The wettability of the copper bottom with respect to tin is superior to a sintered copper-lead strip, mechanically cleaned before bonding.

(5) The lead concentration at the bearing surface can be easily adjusted to any specific use. It can be made sufficiently high to allow for the so-called "whipping action" without sacrificing the necessary strength, toughness, and wear resistance in the rest of the bearing.

Furthermore, powder metallurgy avoids lead segregation altogether, permits great latitude in the relative distribution of lead throughout the bearing, and provides a more suitable bonding interface for the backing sheet. The most favorable results obtained so far were secured by sintering, in hydrogen at 700 to 800 C, a pressed strip consisting of a copper-powder layer at the bottom and a copper-coated lead powder, containing 40–55 per cent lead, at the top.

Courtesy German Railroads

FIG. 5 THE JUNKERS FORTY-PASSENGER AIR LINER WITH FOUR ENGINES AND A DOUBLE-SECTION WING

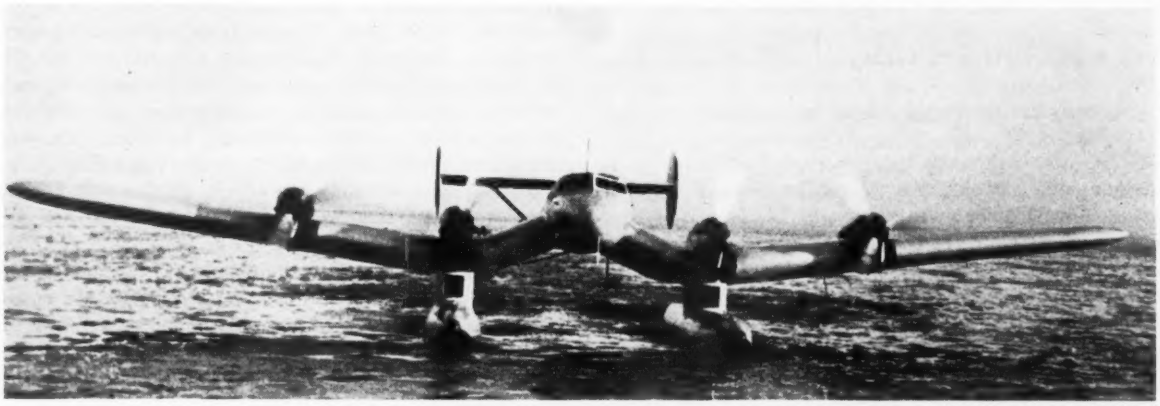
New German Airplanes

ENGINEERING PROGRESS (BERLIN)

REPORTING the progress of airplane construction in Germany during the last few months, E. Berendt, in an article in the November, 1937, issue of ***Engineering Progress*** (Berlin), describes the new aircraft developed for long-distance flying, cruising, instruction, practice, and for the air force. An experimental autogiro built by Prof. H. Focke is also described. Development has tended toward two-engine touring airplanes and four-engine transport and long-distance craft.

In the long-distance category is the "Hamburg Ha 139," shown in Fig. 4, which flew across the North Atlantic from Travemunde, Germany, to New York, and back again, during 1937. It is a cantilever monoplane with a single dented wing containing but one spar, which is of tubular construction. Built into the wing are four water-cooled six-cylinder Junkers Diesel engines with a total power output of 2400 hp. The fuselage is circular in cross section and of all-metal monocoque design. It provides room for a crew of four men and a space with a cubical content of 230 cu ft for freight. The tail unit consists of a braced stabilizer and two circular fins with ailerons which can be adjusted during flight. Below the inside engines are the floats, supported without bracing, with only the tubular carrying members flanged to the wing spar. The Ha 139 has a maximum speed of 185 mph, a cruising speed of 155 mph, and a maximum flying range of 3100 miles.

For transport service on the continent, the Germans have



Courtesy German Railroads

FIG. 4 THE GERMAN TRANSATLANTIC AIRPLANE HA 139

built a Junkers forty-passenger air liner with four "Jumo 211" engines having a starting output of 1100 hp each. See Fig. 5. The wings have a span of 115 ft and an area of 2000 sq ft. With a loaded weight of 21 to 23 tons, the air liner has a maximum speed of 250 mph, a cruising speed of 200 mph, a landing speed of 60 mph, and a cruising range of 1900 miles.

The wing is divided into five parts; the central portion on which is placed the body of the airplane, two intermediate portions with the inside engines mounted therein, and the two tip portions containing the outside engines. The whole wing, including the part under the fuselage, is of the Junkers double-section type, which insures extremely good starting and landing qualities. At the outer wing sections the double wing also serves in the capacity of ailerons. The total length of the cabin is 34.5 ft and its width is 9.8 ft. Double seats 4.1 ft wide are provided on each side of a passageway 1.65 ft wide. In all, there are five single compartments, each of which has eight seats.

The comfort of passengers is further assured by reading lamps arranged above each seat, by the provision of facilities for accommodating small traveling accessories above and below the seat, by effective sound-damping which permits normal conversation during flight, and last though not least, by a general ventilation system which not only supplies air to the cabin but also directly to each individual seat.

To meet the stringent demands of the military air force, a multipurpose training craft has been constructed. It is intended for re-training pilots in handling large aircraft with dual controls, for wireless training, for training in blind and night-flying, and for aerial machine-gun and bomb-dropping practice. Plexiglas, a transparent plastic, is extensively used in the various compartments. The machine gun in the prow is operated with the gunner in a prone position. For training in bomb dropping, a bombing sight is provided together with space for an instructor. Back of the gunner in the prow is the pilot's compartment followed by a compartment for the rear gunner. The airplane has a ceiling of 17,700 ft, a maximum speed of 155 mph, and a cruising speed of 130 mph. This type of craft with several modifications is also used for mail and branch-line transport service in Germany.

An autogiro built by Prof. H. Focke was recently demonstrated in Germany. The machine is both lifted and propelled forward by two horizontally revolving three-bladed lifting rotors which are located, one at each side, at the end of long tubular frameworks. These rotors are operated by means of a gear train from the radial engine, which also drives a cooling fan. No rigid supporting plane is provided. In the event of failure of the engine, the autogiro can land without danger by volplaning.

Engineering-School Students

THE JOURNAL OF ENGINEERING EDUCATION

STATISTICS of enrollments in engineering schools for the academic year, 1937–1938, are given in a series of tables published in the December, 1937, issue of *The Journal of Engineering Education*, published by the Society for the Promotion of Engineering Education.

These figures are the results of replies from 131 institutions in the United States and Canada to requests addressed to 150 institutions which give instruction in engineering. They show total registrations of 84,547 (in 131 institutions) for 1937–1938 as compared with 67,569 (in 119 institutions) for 1936–1937. Five Canadian schools show a total enrollment of 2320.

It is interesting to note that in all engineering courses given, mechanical engineering leads with a total registration of 17,803 for 1937–1938. To this may be added figures of 2262 for aeronautical engineering and 2184 for industrial engineering. Disregarding "unclassified" engineering courses, the next largest groups are electrical engineering with 13,424, and chemical engineering with 12,556.

In undergraduate enrollment by institutions, Purdue has the largest number, 3433, and Armour is second with 3020, of which 1995 are evening students. Other large enrollments in institutions with no evening courses are A.&M. College of Texas 2417, University of Illinois 2378, and Ohio State University 2003.

A table of the number of students taking graduate work in colleges in the United States shows 2924 working for their master's degrees and 472 for their doctor's degrees. The Massachusetts Institute of Technology leads all other schools in enrollments for the master's and doctor's degrees, having registered 318 and 108, respectively. In the Polytechnic Institute of Brooklyn, 275 evening students are enrolled for work for the master's degree, and in Armour Institute of Technology, 193.

Figures of this nature are the more interesting in the light of present-day trends in business since they indicate a continual and healthy growth in the number of undergraduate students, especially of those taking mechanical engineering. Furthermore, they make one realize that the increasing demands of industry for college-trained engineers are being most adequately met by educational institutions.

Invention in the Future

MANCHESTER ASSOCIATION OF ENGINEERS

IN HIS presidential address on Oct. 8, 1937, before the Manchester Association of Engineers (England), F. O. L. Chorlton, member of the Institution of Mechanical Engineers, stated that changes of every kind resulting from new inventions and the increase of knowledge are occurring at an ever-increasing rate.

The extension of research and the new materials which have become available all tend to accelerate them. It might be assumed that there would be no limit to this speeding up, but many influences may arise which would have a retarding effect, some near at hand in point of time, as political, racial, biological, and economic, others far distant, such as the limitations imposed by the energy available for driving our machinery, shortage of materials, exhaustion of the soil, and change of climate.

For many thousands of years, there will be sufficient material to occupy the minds of inventors, according to Mr. Chorlton. In the domain of transport on land, water, and in the air, which is, perhaps, the most interesting field for invention, further reductions will undoubtedly be made in the weights of the prime movers, and possibly in the case of larger airplanes steam will come into its own again. With a greater knowledge of radiation, we may be able to control gravitation in the same way. Such an invention would be revolutionary indeed, and would probably have a greater effect on the conditions of human life than any previous discovery. Transmission of power in bulk through the air will probably come to pass, in which case a beam of energy will be radiated out along each aerial route to be picked up by the passing machines instead of their carrying fuel.

In power production probably the main improvement will be

in the utilization of other liquids than water for the transmission of the energy of the fuel to the revolving motor. Compounding of internal-combustion engines will almost certainly be adopted, with an improvement in efficiency. An internal-combustion turbine will probably come into use. Our production machinery will become more complicated, but this again will be limited by human capacity to control it, and inventors will no doubt devote their attention to methods of automatic control. Entirely automatic production of our daily needs will come more and more into use until only a very few hours of work will be required from each individual.

Wireless transmission will be improved until we shall be able both to see and to speak to anybody in any part of the world. Electric lighting, which is at present making such great advances, will improve in color and in the amount of illumination per unit of electricity used. Some control of the weather may even become possible through the invention of special apparatus.

Future invention is, of course, not confined to engineering. The writer, the artist, the poet, and the architect may be included in the term inventor; anyone, in fact, who by some originality of thought presents to the world a new idea or an old one in a new dress. Those named are handicapped by the meager supply of new material presented to them by the progress of time, but the mechanical inventor has the advantage of an ever-increasing field of action, each innovation extending the area in geometric progression.

Vacations With Pay

METAL TRADES DIGEST

VACATIONS with pay for production employees are said to be granted for the dual purpose of eliminating distinction between office and factory personnel and providing incentives and rewards for continued meritorious service. According to a brief article in the January, 1938, issue of *Metal Trades Digest* (a new publication of the National Metal Trades Association, which, to judge from its contents, is principally concerned with problems relating to industrial relations), vacations with pay are very much in favor with those who enjoy them, as might be supposed, but as far as evaluating their influence on employee relations, the record is far from being unreservedly favorable.

From the results of a survey conducted in July, 1936, the Association assembled statistics that indicate the existence of a number of interesting conditions. For instance, it is said that companies which grant vacations with pay have experienced a slight decline in the rate of labor turnover, although it is admitted that factors other than vacations may have been of greater effectiveness in causing this decline. Moreover, it is said that members of the Association who have granted vacations have noticed no increase in efficiency traceable to such plans.

In so far as effects on "morale" and "loyalty" are concerned, the following figures are given. As to morale: Improvement in morale, 35 per cent; morale improved temporarily, 25 per cent; morale not improved, 25 per cent; company convinced that change and rest from routine work has some beneficial effects on employees, but such effects difficult to evaluate, 15 per cent. As to loyalty: Improvement of loyalty, 30 per cent; temporary improvement of loyalty, 10 per cent; doubt that any improvement has been obtained, 40 per cent; no improvement, as far as can be measured, 20 per cent.

About 90 per cent of the companies reporting indicate that there has been an improvement in employee appreciation of the plant as a "good place to work." The remaining 10 per cent report that they are unable to find any improved appreciation on the part of employee because of such vacation plans.

The Personnel Director

METROPOLITAN LIFE INSURANCE COMPANY

CURRENT problems of labor relations have been demanding an increasing amount of attention from major executives and in many cases have brought about a re-evaluation of industrial-relations policies and of the organization for making these policies effective. Because of the interest in this subject, the Policyholders' Service Bureau of the Metropolitan Life Insurance Company, in a booklet entitled, "Functions of the Personnel Director," presents the results of a survey of methods of handling industrial relations in large and small companies. Executives of 40 organizations east of the Mississippi River were interviewed personally; executives of an equal number of firms cooperated by completing questionnaires. The industrial and commercial fields represented are automotive, electrical, foundry, iron and steel, machine tool, meat packing, paper, petroleum, rubber, textile, banking, chain retailing, department store, insurance, mail order, and public utility.

Some of the points covered in the survey are personnel policies, the personnel program and organization, and the human factor in personnel management. The relation of the personnel director in collective bargaining and in the interpretation of agreements or understandings is discussed. Depending on the size of the company, he may or may not be the one who negotiates the agreement, but in all cases does act in an advisory capacity. If a procedure for handling grievances is established under an agreement, the personnel director sometimes represents the chief executive in such matters. Another duty falling upon the former is to see that grievances are settled with the least possible delay. In one company employing 500 people foremen have full authority to discharge, but if any discharge is questioned by the union, a hearing is conducted by the personnel director. The employee, the union representative, and the foreman all present their evidence, after which a decision is made by the personnel director.

Many of the executives replying believe that one of the greatest shortcomings in personnel management has been a tendency toward too much routine and undue stress on personnel programs and techniques. They feel that the essence of good industrial relations is a management attitude based upon a recognition of these facts: That employees are human beings and react as human beings to the people and conditions surrounding them; that each employee has certain aptitudes and abilities, ambitions and desires, likes and dislikes, individual and family problems; and that good industrial relations become effective through personal contact with employees.

It has been found that, in order to develop a spirit of cooperation, management needs to know and have a better understanding of the individuals employed, to treat them as associates interested in the future of the company, to place them in positions in which they can utilize and develop their abilities, and to take an interest in their individual aspirations and development. Many employers today apparently believe that the well-being and individual development of employees is an end in itself as well as a means to production and profits. When both these objectives are harmonized, real cooperation generally results, because, as one executive pointed out, "Cooperation is a two-way and not a one-way street."

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Radiographic Inspection

To the Editor:

As a part of an intensive investigation into various aspects of producing and controlling the quality of field-welded joints, The Detroit Edison Company, in 1933, prior to the rebuilding of the Conners Creek plant, made a rather careful investigation of X-ray inspection. At that time, the conclusion reached was that such inspection was impractical. Within the last six months, we have carried on a similar investigation. We are ready to concede that (*a*) progress has been made, (*b*) it is feasible to take equipment such as that described by Mr. Isenburger[1] into the field and X-ray joints by his method, and (*c*) the proposed method is a distinct advancement over that proposed and practiced in 1933. We are not ready to concede that X-ray inspection has attained a degree of perfection such that it should be made a mandatory procedure, as he suggests, for all field-welded joints in pressure piping. In fact, we have what we consider to be adequate evidence that it has not reached that state of perfection.

SAMPLES SUBMITTED FOR EXAMINATION

We recently submitted five butt-welded joints in pipe 8-in. diameter, $^1/_2$-in. wall thickness, for examination in the manner proposed by Mr. Isenburger. Four had been removed from the boiler-feed piping system at Conners Creek, when providing feedwater connections to additional new boilers. They had been field-welded, with the pipe in a fixed horizontal position, and had been in service for a period of approximately two years.

The fifth joint was prepared specifically for the examination and contained artificially induced defects such as might be encountered in an actual weld, although we hope, of course, to avoid them. The defects were (*a*) a crack in a portion of the first bead, (*b*) incomplete penetration into the backing ring, and (*c*) six $^1/_4 \times {}^1/_4 \times {}^1/_2$ in. long steel blocks, each having either a hole or a notch of known size extending throughout its length. These blocks were embedded in the weld, and, aside from the void represented by the hole or notch, the shape of the block practically insured that some slag would be trapped in welding around them.

X-ray examination of the four field-welded joints showed the welds to be satisfactory from the standpoint of soundness. However, each weld showed some indication of a lack of penetration into the backing ring. We have been aware of the possibility of such a fault existing, particularly with the form of backing ring supplied at the time these welds were made, but had never found any evidence of it in any of the periodic qualification tests of the men. From each weld, at the location where the X rays indicated the condition to be the most pronounced, we cut two coupons, one for macroscopic examination and one for the standard reverse or back-bend test. Coupons from three welds passed the reverse-bend test but with little margin over the minimum requirement. The fourth one failed to pass. X-ray examination in this instance had performed a real service, showing the existence of a condition that should be avoided. Results of the examination of the fifth weld, supposedly containing eight defects—cracked first bead, lack of penetration into the backing ring, and six voids or slag inclusions, or both—were as follows: The crack was not detected; lack of penetration was detected; three of the six cases of voids or slag were detected; three were not. Radiographic inspection of this weld was 50 per cent effective.

We believe that we know why it was not more effective. In the case of the cracked first bead, the crack was in a plane perpendicular to the axis of the pipe and not parallel to the scarf. This, we believe, is the direction in which cracks, other than transverse cracks, will appear. Detection of such a crack would require an additional exposure, with the central beam directed normal to the pipe axis. This may or may not be practicable, as it involves penetrating two sections of the weld.

In the case of the six voids or inclusions, we believe it is significant that the three which were detected were 5, 10, and 20 deg away from the center of the field, that is a point diametrically opposite the focal spot of the tube, while those which were missed were 20, 30, and 45 deg away. In X-raying this weld, four pairs of exposures were made, so that the field of each exposure was 90 deg. It is evident that the center of the field is at a greater distance from the focal spot of the tube than are the ends of the field. Thus, the field is limited to that part of the circumference for which satisfactory definition can be obtained, using exposure conditions that are correct for the central part of the field. It seems to us that both the appearance of the exographs and the findings with respect to the voids and slag inclusions indicate that, for complete and effective examination, the field should have been limited to 45, rather than 90 deg. I am speaking now specifically of pipe 8 in. diameter, $^1/_2$-in. wall thickness. I do not know what it should be for other sizes and thicknesses.

ECONOMY SECONDARY CONSIDERATION

Now, if we assume that a 45-deg field and an additional exposure normal to the pipe axis would have given us a complete inspection, that would have meant 24 exposures, rather than the 8 which were actually made. The inspection of each of these welds in the present manner, that is, four pairs of exposures per weld, in an X-ray laboratory, not in the field, cost us more than the combined cost of welding and stress relieving.

I do not want to give the impression that we think welded joints must be "cheap" joints. Economy was distinctly a secondary consideration in our selection of welded joints for high-pressure, high-temperature service, and we have utilized every means that seemed to offer a reasonable chance of improving the soundness and safety of those joints. However, in view of the great number of welded joints that have been giving satisfactory service, many of them under severer service conditions than The Detroit Edison Company encounters in its plants, any matter of substantial increased cost must be most carefully evaluated.

I wish to compliment Mr. Isenburger

[1] "Radiographic Inspection," by H. R. Isenburger, Mechanical Engineering, November, 1937, pp. 809–812.

on the progress that he has made. X-ray inspection will be used to a greater extent than at present in connection with experimental procedures. But before agreeing that it should be mandatory, we require greater assurance that it is entirely, rather than partly, effective and that the cost will be justified. Any partly effective safeguard may be more dangerous than no safeguard beyond carefully controlled workmanship. Imposing mandatory requirements for X-ray examination, which in the experience of thoughtful observers has not yet proved itself by any means infallible, is a drastic measure, the imposition of which would be unthinkable in the present stage of development.

D. H. Corey.[2]

To the Editor:

Through a most regrettable oversight, the focus-film distance of Mr. Corey's samples was only 12 in. instead of 20 in. This fact alone accounts for the improper results obtained and for Mr. Corey's conclusions. The correct exposure technique is shown in the accompanying Fig. 1.

H. R. Isenburger.[3]

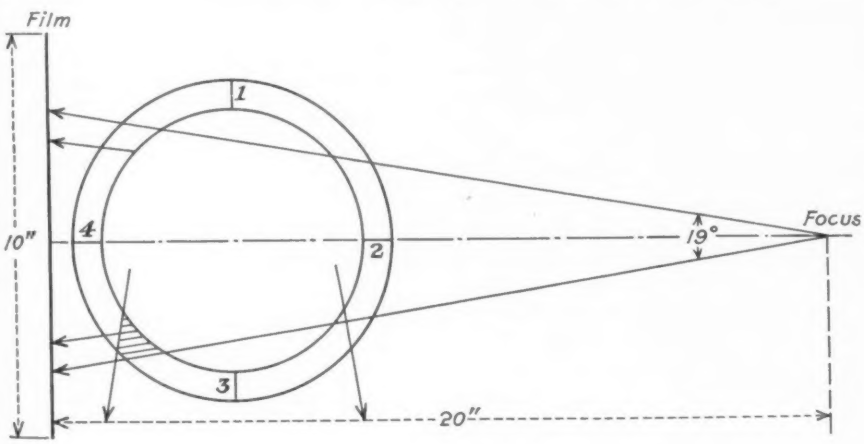


FIG. 1

Plastic Materials

To the Editor:

The firm with which the writer is associated has been using plastics[4] for a number of years. It is our desire to extend the application of these materials, but we have found that plastics as developed to date do not lend themselves to the molding of pieces requiring a high degree of accuracy which has to be maintained permanently. Permissible tolerances as requested from us by commercial molders are far in excess of those generally applied in this industry, and we have found that parts made of plastics are subject to warpage over a comparatively long period of time.

We are greatly interested in information regarding plastic materials that will have minimum shrinkage in the mold and will retain their shape afterward without any perceptible changes. The reply to my question to the speaker as to the possibility of obtaining such materials was not of a particularly encouraging nature.

O. E. Trautmann.[5]

To the Editor:

Molding lenses with accuracy usual to optical instruments is a difficult problem. The material most suited, because of its clarity and index of refraction, is an acrylic resin such as Lucite. Lenses suitable for cheap cameras and spectacle lenses molded from this plastic have been marketed in England and the United States. The quality of pictures taken with a plastic lens is good, and the spectacles recently won honorable mention in the Second Modern Plastics Competition.

Nevertheless, for finer instruments such as microscopes, it is doubtful if any known plastic can be shaped with sufficient accuracy because of inevitable slight shrinkage and warpage.

Harry Burrell.[6]

Surface Quality, X Rays, Electron Beams, and Molecular Rays

To the Editor:

I have read with great interest the review of Schmaltz's book "Technische Oberflächenkunde."[7] In this article, attention is drawn to "Methods with X, electron, and molecular rays," and the statement is made that "these rays penetrate the material." This is only correct for X rays and electron rays. They penetrate the material, although the latter do not pass through more than about six atomic layers, and are diffracted at the *three-dimensional* grating of the crystal lattice. Molecular rays (neutral molecules, moving with thermal velocities unidirectionally and collision free in a vacuum) however, behave differently. O. Stern and his collaborators (1, 2)[8] were able to show that, as was expected, these rays do not enter the crystal but are diffracted at the *two-dimensional* cross grating of a cleavage plane.

A regular diffraction pattern can only be expected if specular reflection can be obtained from the surface. In optics, the condition for specular reflection is that the height of the asperities of the surface projected on the direction of the beam of light should be smaller than one wave length. The de Broglie wave length of molecular rays is of the same order as that of X rays. For hydrogen at zero deg C, it is $\lambda = 1.2 \times 10^{-8}$ cm. With hydrogen molecules at small glancing angles of the order of 10^{-3} radians, Stern and Knauer (1) succeeded in obtaining specular reflection in the order of a few per cent from highly polished glass, speculum metal, and steel surfaces. The intensity of the reflected beam increased steeply with decreasing glancing angle, as the following figures for hydrogen molecules reflected from speculum metal show:

Glancing angle, radians	$2^1/_4 \times 10^{-3}$	2×10^{-3}	$1^1/_2 \times 10^{-3}$	1×10^{-3}
Intensity of reflected beam, per cent	$^3/_4$	$1^1/_2$	3	5

These show that the roughness of these highly polished surfaces was of the order of 10^{-5} to 10^{-6} cm. The intensity of specular reflection was of the same order for all three surfaces, being biggest for speculum metal and smallest for steel.

It might be mentioned in this connec-

[2] Welding Engineer, The Detroit Edison Company, Detroit, Mich. Mem. A.S.M.E.

[3] President, St. John X-Ray Service, Inc., Long Island City, N. Y.

[4] "Plastics Materials," by Harry Burrell, Mechanical Engineering, December, 1937, pp. 917–922.

[5] Mechanical Engineer, Specification Department, Bausch & Lomb Optical Co., Rochester, N. Y.

[6] Ellis-Foster Company, Montclair, N. J.

[7] "Surface Quality," review by E. J. Abbott and Edgar Goldschmidt, Mechanical Engineering, November, 1937, pp. 813–825.

[8] Numbers in parentheses refer to the Bibliography on page 260.

tion that true specular reflection is confined to beams of gases with low critical points, such as hydrogen, atomic hydrogen, and inert gases. The reason for this is that, in the case of molecular rays, the optical condition for specular reflection is necessary though not sufficient. As an additional condition, the time of adsorption of the particles of the beam on the surface comes in. In case this time is not very short, random scattering of the beam takes place, however smooth the surface may be.

Ellett and his collaborators (3, 4, 5) showed that superposed to this random scattering, some sort of reflection is found for heavy, easily adsorbed particles of short de Broglie wave length of the order of 10^{-9} cm, such as mercury. Here the reflection pattern is broad and diffuse (half width 10 to 20 deg). Instead of being a wave phenomenon, this type of reflection is due to the molecules bouncing off the surface like elastic balls, diffuseness of the reflected beam being dependent on the roughness of the surface.

Even for gases with low critical points, such as hydrogen molecules and helium atoms, Stern and Frisch (2) found that, under a sharply defined angle between the plane of incidence and the ion rows of the crystal net plane, the reflected intensity of the beam nearly vanished. That was interpreted by Lennard-Jones and Devonshire (7, 8, 9) by a skidding effect of those molecules along the surface, which hit it with two definite components of momentum relative to the surface.

ROBERT SCHNURMANN.[9]

[9] Research Department, London Midland and Scottish Railway Company, Derby, England.

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8 "The Diffraction and Reflexion of Molecular Rays," by A. F. Devonshire, Proceedings of the Royal Society of London, series A, vol. 156, 1936, pp. 37–44.

9 "The Diffraction of Atoms by a Surface," by J. E. Lennard-Jones and A. F. Devonshire, Proceedings of the Royal Society of London, series A, vol. 158, 1937, pp. 253–268.

TO THE EDITOR:

This technical material submitted by Robert Schnurmann is most interesting and in line with Dr. Schmaltz's position that such methods warrant further work. No attempt was made in the book or in the review to cover the subject but only to suggest the possibilities of these new methods.

E. J. ABBOTT.[10]

[10] Physicists Research Company, Ann Arbor, Mich. Mem. A.S.M.E.

A.S.M.E. BOILER CODE

Revisions and Addenda to Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-180. Revised:

P-180. *a* WHERE THE THICKNESS OF THE SHELL DOES NOT EXCEED 10 PER CENT OF THE INSIDE RADIUS, the maximum allowable working pressure on the shell of a boiler or drum, etc.

Revise the definition for R to read:

R = inside radius of the weakest course of the shell or drum, in. [provided the thickness of the shell does not exceed 10 per cent of the radius. If the thickness is over 10 per cent of the radius, the outer radius shall be used for R.] In a locomotive type boiler with a tapered course, the radius shall be the maximum in such course.

Add the following as (*b*):

b Where the thickness of the shell exceeds 10 per cent of the inside radius, the maximum allowable working pressure on the shell of a boiler or drum for temperatures not to exceed 700 F, shall be determined as in (*a*) by the following formula:

$TS \times E/FS(K^2-1)/(K^2+1)$ = maximum allowable working pressure, lb per sq in., where

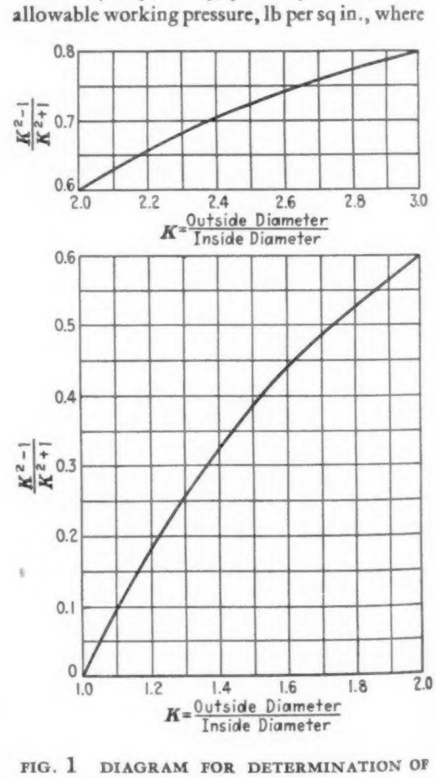


FIG. 1 DIAGRAM FOR DETERMINATION OF THE FACTOR REPRESENTING THE RATIO OF OUTSIDE DIAMETER TO INSIDE DIAMETER

$K = R + T/R$, or, ratio of outside diameter to inside diameter. Values of $(K^2-1)/(K^2+1)$ for given values of K may be obtained from Fig. 1.

Designate remaining two sections as (*c*) and (*d*).

PAR. P-186*c*. Revise last sentence:

In vertical tubular and firebox types of boilers, the flanged-in bottom edges of the plates may be attached by fusion welding provided the CROWN SHEET IS SUSPENDED FROM THE UPPER TUBE SHEET OR WRAPPER SHEET BY TUBES OR STAYS, the load ON THE PLATES IN THE WATER LEG due to the internal pressure is carried by staybolting and the inside width of the water leg . . . etc.

PAR. A-43. Insert the following as the second section:

When boilers of different maximum allowable working pressures with minimum safety valve settings varying more than 6 per cent are so connected that steam can flow toward the lower pressure units, the latter shall be protected by additional safety valve capacity, if necessary, on the lower pressure side of the system. The additional safety valve capacity shall be based upon the maximum amount of steam which can flow into the lower pressure system. The additional safety valves shall have at least one valve set at a pressure not to exceed the lowest allowable pressure and the other valves shall be set within a range not to exceed 3 per cent above that pressure.

SPECIFICATION S-4. Revise Par. 4 to read:

4 *Chemical Composition.* The steel shall conform to the following requirements as to chemical composition:

		Class 1	Class 2
Carbon, max, per cent		0.35	0.50
Manganese, per cent		0.50–0.90 [0.40–0.70]	0.50–0.90
Phosphorus, max, per cent	acid	0.05	0.05
	basic	0.035	0.035
Sulphur, max, per cent		0.05	0.05
SILICON, PER CENT....		NOT OVER 0.30 IN.	

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Utilization of Wood

TECHNOLOGIE DES HOLZES. By F. Kollman. Julius Springer, Berlin, Germany. Cloth, 6 × 9 in., 764 pp. Price $20.18.

REVIEWED BY THOMAS D. PERRY[1]

IN a comprehensive work that is intended more for research into wood utilization than for current factory practice the author discusses at some length structure, growth, physics, and chemistry of wood. Sections are devoted to natural and mechanical drying with a description of kiln designs and the testing of wood for dryness. The analysis of the fundamentals of cutting wood by saws, knives, cutterheads, and boring tools is particularly valuable. Careful attention is given to bending solid wood, as well as to forming plywood, with a complete outline of wood adhesives and methods for testing glue joints. The discussion of holding power of nails, screws, bolts, and various types of metal connectors for timber joints is unusually illuminating. The section given over to plywood is prefaced by a full description of veneer production. In this section, various types of construction are also explained and illustrated, and the practical use of multiply developments is constructively discussed, showing many forms of utilization that are now available to plywood bonded with resin adhesives. The last chapter is devoted to the intelligent use of wood by-products.

The illustrations, tables, and charts are so well-arranged that they can be helpful even to those whose knowledge of German is limited.

As a whole, the volume is an excellent example of an engineer's analysis of the characteristics of wood, with constructive suggestions for economic utilization of this abundant raw material in its various combinations.

[1] Engineer, The Resinous Products & Chemical Co., Inc., Philadelphia, Pa. Mem. A.S.M.E.

Statistical Methods

STATISTICAL METHODS. By George W. Snedecor. Collegiate Press, Inc., Ames, Iowa. Cloth, 6 × 9 in., 333 pp. $3.75.

REVIEWED BY E. DILLON SMITH[2]

IT will be a great satisfaction to the beginner, the advanced student, and the practicing statistician to know that Professor Snedecor has written a book that not only covers the elementary phases of statistical methods but also takes the more usable work of Prof. R. A. Fisher and shows, simply, its concrete application. The more ambitious student of statistics will have no trouble in applying his methods and applications to the pure sciences and concrete engineering problems. This book by Snedecor is truly the most outstanding presentation that has appeared in America for a great number of years.

As a brief outline of the elements treated in this book, the following are important: Attributes, individual comparisons, group comparisons, short-cut methods in computations, regression, correlation, analysis of variance with a single criterion of classification, and analysis of variance with two criteria of classification.

It is significant that this book describes, and completes in a few pages, the description of the more simple things in statistics which generally consume half of an ordinary text. The Chi-square test of Pearson is introduced early in testing a hypothesis. This is unusual in a book of this type. Such things as explaining the reason for the squaring of the deviation from a mean is also explained early in the book, as is the subject of degrees of freedom when computing a statistic as an estimate of a parameter of the population.

In fitting of regression lines to data, Professor Snedecor not only explains the more customary methods but also has introduced computation techniques that facilitate their determination. He has very simply shown how to fit an orthogonal polynominal to any series of data; he has shown how to test the significance of each term and interpret the meaning of such a test.

A most thorough treatment of the analysis of variance in all its ramifications has been presented simply under one cover, probably for the first time. In connection with Professor Snedecor's general discussion of the analysis of variance, comment has been made on the design of experiments. This is the first American rendition ever given in a textbook. It clearly explains the difference between planning and just blindly performing the experiments. This book should have an exceptionally wide acceptance, not only as a textbook but also as a practical guide to the statistician.

[2] Assistant to President, Transcontinental & Western Air, Inc., Kansas City, Mo. Jun. A.S.M.E.

Books Received in Library

A.S.T.M. STANDARDS ON RUBBER PRODUCTS, prepared by Committee D-11 on Rubber Products. Methods of testing, specifications. November, 1937. American Society for Testing Materials, Philadelphia, 1937. Paper, 6 × 9 in., 238 pp., illus., diagrams, charts, tables, $1.25. This publication gives the standards issued in this field by the A.S.T.M., in their latest approved form. There are 15 methods of testing and 10 specifications, covering rubber and rubber products. A select bibliography is included.

THE ADMINISTRATION OF FEDERAL GRANTS TO STATES. By V. O. Key, Jr. Published for the Committee on Public Administration of the Social Science Research Council by Public Administration Service, Chicago, 1937. Cloth, 6 × 9 in., 388 pp., tables, $3.75. One of a series of studies of the administrative problems of the social-security program. The scope of this book is limited strictly to an examination and analysis of administrative practices, policies, and problems from several federal agencies, and jointly financed state activities. Larger questions of public policy in connection with grants-in-aid are omitted.

DER BAU UND DER BETRIEB DER KUPOLÖFEN: II. Der Betrieb von Kupolöfen. (Die Betriebspraxis de Eisen-, Stahl- und Metallgiesserei, Heft 20.) Wilhelm Knapp, Halle (Saale), 1937. Paper, 7 × 9 in., 235 pp., illus., diagrams, charts, tables, 8.62 rm. The second section of this handbook of foundry practice is devoted to cupola operation. The raw materials, pig-iron, scrap, alloys, and fuels are described in the first chapter, followed by a chapter on the chemistry and physics of the melting process. A chapter is then devoted to the calculation of the cupola charge for various castings. The final chapter treats of cupola control.

BOOK OF A.S.T.M. TENTATIVE STANDARDS, 1937. American Society for Testing Materials, Philadelphia, 1937. Paper, 6 × 9 in., 1629 pp., diagrams, charts, tables, $7. Annual list of tentative specifications, methods of testing, definitions of terms and recommended practices covering materials of engineering and the allied testing field, proposed by the American Society for Testing Materials.

CAR BUILDERS' CYCLOPEDIA. Fourteenth edition, 1937. Simmons-Boardman Publishing Corporation, New York, 1937. Cloth, 8 × 12 in., 1308 pp., illus., diagrams, charts, tables, $5. The new edition of this standard reference book follows the general arrangement of the preceding one, but various improvements in detail have been made, which facilitate quick reference. Many new designs of cars and appliances have been added, especially of modern passenger cars and motor trains.

THE CHEMISTRY OF PETROLEUM DERIVATIVES, Vol. 2. By C. Ellis. Reinhold Publishing Corporation, New York, 1937. Leather, 6 × 9 in., 1464 pp., illus., diagrams, charts, tables, $20. This book contains the subject matter of volume one, which appeared in 1934, by providing a record of work since that date. The two volumes form an amazingly comprehensive review of the literature of petroleum chemistry, which is indispensable to every investigator. The present volume contains 6000 references. In addition to bringing its predecessor up to date, it includes new chapters on the synthesis of hydrocarbons, petroleum hydrocarbons in anaesthesia, petroleum asphalts, and thermodynamics and its applications to petroleum.

DIAGONAL FUNCTIONS AND THEIR OPERATION. By C. L. Clarke. Chas. L. Clarke, Newton, Mass., 1937. Cloth, 8 × 11 in., charts, diagrams, tables, $5. This book describes a new branch of applied mathematics. The foundation for diagonal functions is the half-cycle trigonometrical sine curve, further dealt with in offset and sheared form, and all referred to rectangular axes with an origin common to them and the base of the sine curve midway between them. The application of the functions to finding an equation for a smooth curve of single flexure that will fit a series of points derived from experimental research is illustrated by examples.

ELEMENTARY THEORY OF OPERATIONAL MATHEMATICS. By E. Stephens. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 8 in., 313 pp., tables, diagrams, $3.50. An extension of the fundamentals of Heaviside's work in operational mathematics. The object of the book is to describe the simplification of the operators in differential and integral calculus by algebraic methods, and to reinterpret the resulting forms as operators for easier handling. Useful formulas and brief historical material are given in appendixes, and a large bibliography is included.

DIE EMAILLIERUNG DES GUSSEISENS. (Die Betriebspraxis der Eisen-, Stahl- und Metallgiesserei, Heft 23.) By E. Schütz. Wilhelm Knapp, Halle (Saale), 1937. Paper, 7 × 9 in., 150 pp., illus., diagrams, charts, tables, 6.45 rm. A practical handbook on the enameling of iron castings. The raw materials, the preparation and composition of enamels, the ovens and methods are described.

THE ENGINEER'S WHO'S WHO, 1937, compiled by M. E. Day. D. M. A. Co., Ltd., London, 1937. Cloth, 6 × 9 in., 183 pp., 20s. A biographical directory of 1300 men of importance in the engineering field, covering Great Britain and Ireland.

THE FLOW OF HOMOGENEOUS FLUIDS THROUGH POROUS MEDIA. By M. Muskat, with an introductory chapter by R. D. Wyckoff. McGraw-Hill Book Co., New York, 1937. Cloth, 6 × 9 in., 763 pp., illus., diagrams, charts, tables, $8. A comprehensive treatment of the subject, covering all typical problems of practical interest, with particular stress on illustrations of the various analytical methods available for solving flow problems. It is hoped that the book will be of value in the study of conditions met with in oil production, hydrology, irrigation, dam construction, and other such fields. Summaries containing the quantitative results are given for most of the chapters, and there is an appendix summarizing the whole book.

FLUCHTENTAFELN FÜR FEUCHTE LUFT. By H. Jahnke. J. Springer, Berlin, 1937. Paper, 8 × 12 in., 31 pp., diagrams, charts, tables, 12.60 rm. The construction of nomographic charts for moist air and their practical uses are described in this brochure. Seven nomographs are included which provide for the calculations usually required.

THE FORMATION OF THE NEW ENGLAND RAILROAD SYSTEMS. By G. P. Baker. Harvard University Press, Cambridge, Mass., 1937. Cloth, 6 × 9 in., 283 pp., maps, charts, diagrams, $3.50. A comprehensive, detailed account of the growth and acquisitions of the principal New England railroads from about 1840 to 1900. The introduction discusses briefly the physical and economic geography and the economic history of New England for this period. The object of the book is to present a historical background for a consideration of contemporary problems of and forces behind railroad combinations in New England.

FUNDAMENTAL PRINCIPLES OF QUANTUM MECHANICS. By E. C. Kemble. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 10 in., 611 pp., diagrams, charts, tables, $6. The basic technique of elementary (nonrelativistic) quantum mechanics is treated in this book, including its philosophical and mathematical background. Wave mechanics, dynamical variables and operators, matrixes, atomic structure and related problems are handled in an exacting, but not tediously complex, manner, assuming the mathematical background of the reader to be of graduate rank.

GLOSSARY OF PHYSICS, compiled and edited by L. D. Weld. McGraw-Hill Book Co., New York and London, 1937. Cloth, 5 × 8 in., 255 pp., $2.50. This glossary contains definitions of over thirty-two hundred physical terms, including many from adjacent fields that are often used in physical literature. The definitions are clear and concise and are intended to be informative rather than decisively authoritative. They are frequently accompanied by references to sources of further information.

Great Britain. Air Ministry. Aeronautical Research Committee Reports and Memoranda, No. 1699. REPORT ON PUSS MOTH ACCIDENTS, Complete with Appendixes. 1937. His Majesty's Stationery Office, London. Cardboard, 10 × 13 in., 388 pp., illus., diagrams, charts, tables, £1, 10s. This report gives the conclusions of an investigating committee which was appointed to account for a few serious failures of airplanes of a design which has been manufactured in large numbers and flown safely in all parts of the world. The report reviews the evidence in each case exhaustively, discusses possible causes, and gives the results of model tests. In general, the conclusions attribute the accidents to flutter and emphasize the importance of making routine calculations or experiments on flexibility for each airplane design.

GRUNDLAGEN DER FLUGZEUGNAVIGATION. By W. Immler. Third edition. R. Oldenbourg, Munich and Berlin, 1937. Paper, 8 × 11 in., 178 pp., illus., diagrams, charts, tables, 12 rm. A treatise on the principles of aerial navigation. After a brief discussion of maps and charts comes a large section on finding and holding a course, covering the compass and other navigation instruments, the use of maps and charts, and the influence of and allowance for wind pressure. The next two sections cover terrestrial and astronomical position finding. There are tables, sample charts, and a short chapter on long-distance navigation.

HIGH SPEED DIESEL ENGINES. By A. W. Judge. Second edition, revised. D. Van Nostrand Co., New York, 1935. Leather, 6 × 9 in., 347 pp., illus., diagrams, charts,

tables, 18s, $7.50. An elementary textbook on the theoretical and practical aspects of the high-speed compression-ignition engine. Fuel handling is emphasized, including filters, injection systems, combustion methods, etc. There are also descriptions of standard and special types of engines for stationary, railway, automobile, and aircraft use. Appendixes contain material concerning wear and service experience of such engines.

HOW TO HANDLE GRIEVANCES. By G. Gardiner. Elliott Service Co., New York, 1937. Paper, 5 × 8 in., 52 pp., $0.60; paper, $0.45. A presentation, in simple, practical form, of the fundamental principles which have been found effective in the handling of workmen's grievances.

HOW TO MAKE ALIGNMENT CHARTS. By M. G. Van Voorhis. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 9 in., 114 pp., diagrams, charts, tables, $2.50. A practical implement for engineers and designers, showing how to make nomographic or alignment charts for the solution of engineering and other formulas. The treatment is arranged so that equations or formulas may be matched with listed type forms and the nomogram constructed by following concisely stated directions accompanied by illustrations. A brief outline of theory is given in the appendix.

HOW TO USE PICTORIAL STATISTICS. By R. Modley. Harper and Brothers, New York and London, 1937. Cloth, 6 × 10 in., 170 pp., illus., diagrams, charts, maps, tables, $3. The technique of producing pictorial charts is presented clearly and practically in this handbook, which presents the methods devised by Dr. Otto Neurath of Vienna and constantly becoming more popular. There is a select bibliography on pictorial statistics.

A HUNDRED YEARS OF MECHANICAL ENGINEERING. By E. Cressy. The Macmillan Co., New York, 1937. Cloth, 6 × 9 in., 340 pp., illus., diagrams, charts, tables, $4.25. An outline of developments in the more important departments of mechanical engineering, and in its application to a number of other industries and public services during the last hundred years. The three parts are: Production and distribution of power; materials and processes; and applications of power.

HYDRAULICS. By R. L. Daugherty. Fourth edition. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 10 in., 460 pp., illus., diagrams, charts, tables, $3.50. The new edition of this well-known text is considerably larger than its predecessor, 125 pages having been added. The presentation has also been generalized so as to apply to all fluids, thus affording a work on fluid mechanics applied to practical engineering. The text is based on the principles of dimensional analysis and the basic theorems of mechanics. The principal attention is devoted to broad fundamental principles.

INDIAN WATER POWER PLANTS, a companion volume to Hydro-Electric Installations of India. By Shiv Narayan. Published by Brij Narayan, Poona Electric Supply Co., Ltd., Ganeshkhind Road, Poona 5, India, 1937. Cloth, 7 × 10 in., 172 pp., illus., maps, tables, 5 rupees. Descriptive information concerning hydroelectric plants and projects of the past decade in India and Burma, geographically divided, showing the progress and present position of Indian hydroelectric power. Supplementary information to that contained in an earlier book on this subject by the same author.

INDUSTRIAL COLD ADHESIVES. By R. Dulac, English edited by J. L. Rosenbaum. J. B. Lippincott Co., Philadelphia and New York, 1937. Leather, 6 × 9 in., 192 pp., tables, $3.50. A translation of a French book covering the general subject of the manufacture of industrial cold adhesives. The main aspects treated are raw materials, plant, labor, and costs. A chapter on sodium-silicate adhesives and some supplementary matter have been added to the original French text.

THE INTERNAL COMBUSTION ENGINE, Vol. 1. By D. R. Pye. Second edition. Clarendon Press, Oxford, England; Oxford University press, New York, 1937. Cloth, 6 × 10 in., 294 pp., diagrams, charts, tables, $5. This work presents a concise, yet comprehensive, review of the principles which underlie the design and operation of the internal-combustion engine. In the new edition the numerical data have been recalculated upon the basis of the latest figures for specific heats and dissociation constants. New material has been added on nonvolatile fuels and the characteristics of their combustion in the compression-ignition type of engine. The chapter on detonation in the gasoline engine has been rewritten, and the results of recent research work have been incorporated throughout the book.

INTERNATIONAL ACETYLENE ASSOCIATION. Official Proceedings, 37th Annual Convention, St. Louis, Mo., November 18–20, 1936. International Acetylene Association, New York, 1937. Cloth, 6 × 9 in., 240 pp., illus., diagrams, tables. In addition to the customary business transactions of the organization and the membership list, there are numerous technical papers, mainly on acetylene welding.

INVENTIONS AND THEIR MANAGEMENT. By A. K. Berle and L. S. De Camp. International Textbook Co., Scranton, Pa., 1937. Leather, 733 pp., illus., diagrams, maps, charts, tables, $4.50. The object of this book is to present a coordinated treatment of the problems confronting inventors and businessmen in developing ideas into industrial property of value. The various pitfalls and special points are illustrated by actual cases. An appendix contains a bibliography, a list of libraries containing patent-office publications, and a glossary of words and phrases.

JAHRBUCH 1937 DER DEUTSCHEN LUFTFAHRTFORSCHUNG unter Mitwirkung des Reichsluftfahrtministeriums, der Luftfahrtforschungsanstalten und -Institute sowie der Lilienthal-Gesellschaft. R. Oldenbourg, Munich and Berlin, 1937. Cloth, 8 × 12 in., paging in 3 sections, illus., diagrams, charts, tables, 30 rm. Yearbook of German aeronautical research, covering the activities, officers, and committee reports of the various organizations in that field. The volume also contains many papers presented to these organizations, on all phases of aeronautical investigations.

KOHLE, KOKS, TEER. Vol. 36: ANALYTISCHE METHODEN, by A. Jenkner. Wilhelm Knapp, Halle (Saale), 1937. Bound and paper, 95 pp., illus., diagrams, charts, tables, paper, 5.48 rm.; bound, 6.38 rm. Analytical methods and tables for the supervision and management of the benzene plants of coke and gas works. Covers the determination of the properties and constituents of raw and processed gases, washing oil, and crude and purified benzene.

KEMPE'S ENGINEER'S YEAR-BOOK, 1938. Forty-fourth edition, revised by L. St.L. Pendred. Morgan Bros., Ltd., London, 1938. Cloth, 5 × 7 in., 2816 pp., illus., diagrams, charts, tables, 31s 6d. An annual British publication covering modern practice in civil, mechanical, electrical, marine, gas, aero, mine and metallurgical engineering, containing formulas, rules, tables, data, and memoranda. There are also sections on patents, depreciation, legal questions, and costs. At the end there are some 200 pages of descriptions of particular pieces of equipment of all kinds.

LABOR'S SEARCH FOR MORE. By M. Keir. Ronald Press Co., New York, 1937. Cloth, 6 × 9 in., 527 pp., $3.50. This book endeavors to present a record of the struggles, in recent times, of ordinary persons to improve their lot. The included material is intended to furnish an insight as to why workers have been and are seeking "more:" more security, more income, more leisure. Strikes, trials, political campaigns, and mechanization are considered along with general economic data.

LANDWIRTSCHAFTLICHER WASSERBAU. (Handbibliothek für Bauingenieure, vol. 7, part 3, edited by R. Otzen.) By G. Schroeder. Julius Springer, Berlin, 1937. Cloth, 7 × 10 in., 397 pp., illus., diagrams, charts, tables, 36 rm. Vol. 7 of the hydraulics section of "Handbibliothek für Bauingenieure," covering agricultural hydraulics. The early chapters contain a brief treatment of fundamental soil and stream science, and such botanical and meteorological information as is necessary. The later chapters take up drainage through small and large water courses (including regulation), irrigation, and land reclamation.

LÄRM- UND ERSCHÜTTERUNGSABWEHR IM HOCHBAU, edited by W. Zeller. V.D.I. Verlag, Berlin, 1937. Paper, 6 × 8 in., 70 pp., illus., diagrams, charts, tables, 4.50 rm. This pamphlet on noise and vibration prevention covers acoustical concepts, methods of noise and vibration measurement, design, construction, and installation of equipment, and legal questions in connection with the subject.

LUBRICATING GREASES: Their Manufacture and Use. By E. N. Klemgard. Reinhold Publishing Corporation, New York, 1937. Leather, 6 × 9 in., 873 pp., illus., diagrams, charts, tables, $15. A comprehensive treatise on the chemistry and technology of lubricating greases. Chemical and physical properties are fully given for various types of greases, and the fundamental theories underlying the manufacturing processes are discussed, as well as the raw materials, design, and management of grease plants. In addition, the costs, profits, and economic significance of the products are treated. An appendix contains analytical methods and tests.

MANAGERIAL CONTROL, Instruments and Methods in Industry. By J. G. Glover and C. L. Maze. Ronald Press Co., New York, 1937. Cloth, 5 × 8 in., 574 pp., diagrams, charts, tables, $4.50. Means and methods for obtaining greater efficiency in manufacturing processes are discussed. The major part of the

book is devoted to cost control in the various phases of industrial activity. The subjects of organization, records, accounts, wage systems, and the selection of a cost system are also treated.

MANUAL OF A.S.T.M. STANDARDS ON REFRACTORY MATERIALS, prepared by Committee C-8 on Refractories. November, 1937. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 180 pp., illus., diagrams, charts, tables, $1.25. This manual gives in their latest form all the specifications, test methods, and definitions in this field which have been developed by the Society. In addition it includes detailed methods for the interpretation of test data, surveys which show the service conditions of refractories in important consuming industries, and tables of the composition of the standard samples supplied by the Bureau of Standards.

MANUAL OF LATHE OPERATION and Machinists Tables. Atlas Press Co., Kalamazoo, Mich., 1937. Leather, 6 × 9 in., 234 pp., illus., diagrams, charts, tables, $1. Concise, practical treatment of machining operations on metals and plastics, including the theory of metal cutting, lathe care, and lathe attachments for various purposes. A small section includes various tables of use to machinists.

MANUAL OF MATHEMATICS AND MECHANICS. By G. R. Clements and L. T. Wilson. McGraw-Hill Book Co., New York and London, 1937. Leather, 6 × 9 in., 266 pp., diagrams, charts, tables, $3.75. Facts and formulas useful in courses in mathematics and mechanics, also for general reference work. The numerical tables are mainly to four significant figures. Subjects covered include: Logarithms, trigonometrical functions, algebraic and geometrical formulas, hyperbolic functions, integrals, vectors, and properties of planes and solids.

MECHANICS AND HEAT. (Physics for Technical Students.) By W. B. Anderson. Third edition. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 9 in., 376 pp., illus., diagrams, charts, tables, $2.50. This first volume of the "Physics for Technical Students" set covers only mechanics and heat. Sound, light, electricity, and magnetism are covered in a second volume. Following the section on mechanics and preceding the section on heat comes a section on properties of matter. The material is intended as an elementary textbook on the subjects considered with emphasis on the practical application of physical principles.

MODERN MANAGEMENT. By J. E. Walters. John Wiley & Sons, New York, 1937. Cloth, 6 × 9 in., 337 pp., diagrams, charts, tables, $3. A presentation of the methods of modern management and the application of the scientific method to the various phases of that management. Actual procedures are given in the various chapters, the titles of which correspond to the divisions of the definition of modern management: Methods, money, men, materials, manufacturing, marketing, measurement.

MODERN THEORIES OF INTEGRATION. By H. Kestelman. Clarendon Press, Oxford, England; Oxford University Press, New York, 1937. Cloth, 7 × 10 in., 252 pp., tables, $5.50. Concerned primarily with the theory of Lebesgue integration as simplified by C. Carathéodory, this book is so designed as to be intelligible to one having a knowledge of elementary analysis. It identifies the problems of integration with those of the theory of measure. The subject matter includes material on Riemann integration, extensions of the Lebesgue integral, and Fourier series. There is an index of definitions and symbols.

OIL BURNING. By H. A. Romp. Martinus Nijhoff, The Hague, 1937. Cloth, 7 × 10 in., 336 pp., illus., diagrams, charts, tables, 12 guilders. The first section of this book comprises a very complete history of oil burning and oil burning mechanisms. Section 2 covers the basic principles of oil burning, including certain modern theories of combustion and methods for the improvement of the combustion process. Section 3 contains classified descriptions of modern oil-burning devices. This section is amplified by a set of separate tables. There is a bibliography.

THE PHYSICAL TREATISES OF PASCAL, translated by I. H. B. and A. G. H. Spiers, with introduction and notes by F. Barry. Columbia University Press, New York, 1937. Cloth, 6 × 9 in., 181 pp., diagrams, $3.25. This latest addition to the "Records of Civilization" series is a translation of Pascal's classic "Treatises on the equilibrium of liquids and on the weight of the mass of the air." Accompanying this work are fragments of two other works on the same subject by Pascal, and translations of excerpts from the mentioned writings of Stevin, Galileo, and Torricelli. The book is a useful addition to the history of science.

RICHTLINIEN FEINMECHANISCHER KONSTRUKTION UND FERTIGUNG. By A. Schroeder. Union Deutsche Verlagsgesellschaft, Roth & Co., Berlin, 1938. Cloth, 7 × 10 in., 194 pp., diagrams, charts, tables, 25 rm. Suggested methods of design and manufacture of various mechanical parts produced by cutting, stamping, drawing, pressing, and casting. Illustrations demonstrate ways to avoid weaknesses or methods giving greater economy in production, the general aim being to improve efficiency and decrease costs.

RICHTLINIEN FÜR DEN VORRICHTUNGSBAU. II. ERGÄNZUNGSLIEFERUNG. Edited by Ausschuss für Vorrichtungen der Arbeitsgemeinschaft deutscher Betriebsingenieure des Vereines deutscher Ingenieure. V.D.I. Verlag, Berlin, 1937. Paper, 8 × 12 in., 17 pp., diagrams, charts, tables, 1.80 rm. A supplementary leaflet to the V.D.I. "approved methods for the construction of machinery," giving tabular specifications of the dimensions and weights of cast bar and flat shapes, and illustrations of proper types of feet or bases and fastening or locking mechanisms.

SEGMENTAL FUNCTIONS, Text and Tables. By C. K. Smoley. C. K. Smoley & Sons, Scranton, Pa., 1937. Leather, 5 × 7 in., 184 pp., diagrams, tables, $5. Description of a new practical method for solving problems dealing with parts of a circular segment. The segmental functions are ratios of the various linear measurements of a segment (cf. trigonometric functions), and the major part of the book consists of logarithmic tables for these functions. Logarithms of segment areas and other useful tabular data are also included.

STATISTICAL YEAR-BOOK OF THE WORLD POWER CONFERENCE No. 2. Edited by F. Brown, World Power Conference, London. Central Office, American Committee, World Power Conference, Interior Building, Washington, D. C., 1937. Cloth, 9 × 11 in., 132 pp., tables, 20s. Statistics of the resources, production, stocks, imports, exports, and consumption of power and power sources in all countries from which information was available, mainly for 1934–1935. Power sources are divided into four classifications: Solid fuels; liquid fuels; gaseous fuels; water power and electricity.

SYMPOSIUM ON CORROSION TESTING PROCEDURES, held at the Chicago Regional Meeting, American Society for Testing Materials, March 2, 1937, continued at the Fortieth Annual Meeting, July 1, 1937. American Society for Testing Materials, Philadelphia, 1937. Cloth and paper, 6 × 9 in., 131 pp., illus., diagrams, charts, tables; paper, $1.25; cloth, $1.50. This pamphlet contains seven papers upon the problems of corrosion testing, with discussions. The papers discuss: the principles of corrosion testing; atmospheric corrosion testing; salt-spray testing; an electrical resistance method of determining corrosion rates; alternate-immersion and waterline tests; standardizing liquid corrosion tests; and soil-corrosion testing.

SYNTHETIC RESINS AND ALLIED PLASTICS. Edited by R. S. Morrell in collaboration with T. Hedley Barry, R. P. L. Britton, and H. M. Langton, Oxford University Press, New York, 1937. Cloth, 6 × 9 in., 417 pp., illus., diagrams, charts, tables, $11. This volume supplements "Natural and Synthetic Resins," published in 1928, by presenting the advances in the field of synthetic resins during the last decade. The first chapter summarizes the chemical and physical properties of the most important classes. Following are chapters upon the preparation and properties of the various plastics, molding, the causes of resinification, and the identification and testing of synthetic resins.

TECHNISCHE STRAHLUNGSAUSTAUSCHRECHNUNGEN. By E. Eckert. V.D.I. Verlag, Berlin, 1937. Paper, 6 × 8 in., 61 pp., illus., diagrams, charts, tables, 6 rm. This volume aims to supply a comprehensive account of the radiation of energy in a form adapted to the needs of engineers. Special attention is given to the exchange of radiant energy between bodies of different shapes, and to the problems of illumination and heat exchange.

TIMBER PRODUCTS AND INDUSTRIES. By N. C. Brown. John Wiley & Sons, New York, 1937. Cloth, 6 × 9 in., 316 pp., illus., diagrams, charts, tables, $3.50. About one half of the total volume of wood harvested each year in America consists of other products than lumber. This volume is concerned with the harvesting of these products and their utilization by conversion into useful commodities. The production of cross-ties, posts and shingles, of distillation products and naval stores, of boxes and barrels, and of excelsior and wood flour is described. A chapter is devoted to wood as fuel and another to such miscellaneous products as nuts and Christmas trees. There is a bibliography.

UEBER DEN BAU UND DEN BETRIEB VON KREMATIONSÖFEN. (Separatabdruck aus dem Jahresbericht des Verbandes Schweizer. Feuerbestattungsvereine.) By P. Schläpfer. Verband Schweizer, Zürich, Switzerland, Feuerbestattungsvereine, 1936. Paper, 6 × 8 in., 42 pp., illus., diagrams, charts, tables. A discussion of the development, construction, and operation of cremation furnaces. A table of data from various European crematories is included.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

The A.S.M.E. Spring Meeting at Los Angeles, March 23–25, 1938

Program of Technical Papers, Entertainment, and Inspection Trips, Women's Events

THE A.S.M.E. Spring Meeting at Los Angeles, March 23–25, is the first meeting of the Society to be held on the Pacific Coast in ten years, and to make this meeting national in character a splendid program has been prepared, including papers submitted by the Aeronautic, Applied Mechanics, Fuels, Hydraulic, Management, Petroleum, and Process Industries Divisions.

The detailed technical program appears on page 266 of this isue.

The Western Metals Congress and Exposition sponsored by the American Society of Metals will be held in Los Angeles during the same week as our Spring Meeting and the technical sessions of the Congress will be held at the Los Angeles Biltmore Hotel, also the A.S.M.E. headquarters. Many of the papers to be presented at the Western Metals Congress are being given by members of the A.S.M.E. and all of them will be of interest to our members.

The Tour

The official tour, which has been announced in previous issues of MECHANICAL ENGINEERING and for which a special descriptive circular has been prepared and mailed is attracting considerable attention. It offers an opportunity for a visit to the Indian country in New Mexico and a two-day stop at the Grand Canyon en route to the meeting. The return trip, which will be made on the *S. S. Virginia* of the Panama Pacific Line, will afford an opportunity for a two-week ocean trip with visits to Mexico, the Panama Canal, and Havana, Cuba. Incidentally, the sailing of the *Virginia* is the last scheduled sailing of the three sister ships of the Panama Pacific Line from California to New York. This service is being discontinued and these vessels are being put in the service to South American ports. The A.S.M.E. tour, therefore, offers a last chance to make this delightful cruise.

Entertainment and Inspection Trips

Wednesday Afternoon

To the extensive oil fields adjacent to Los Angeles.

To Kobe, Inc., makers of flamecut oil-well strainers and a novel type of deep-well oil pump.

To California Institute of Technology where can be seen work on the grinding of the mirror for the 200-in. telescope, as well as the very complete pump-testing laboratory where much development work was done on the large pumps for the Metropolitan Water District.

To the Vernon Diesel plant of 25,000 kw capacity, the largest in the United States.

To the Long Beach Steam plant of the Southern California Edison Company, Ltd., showing the modern methods of burning natural gas and oil.

Thursday Afternoon and Evening

To the motion-picture industry. In the afternoon visits will be made to the studios of Technicolor, Walt Disney, and the R.C.A., where the various processes will be explained and demonstrated. Dinner will be served at the Hawaiian-Paradise Café in Hollywood, after which a most unusual and instructive program will be enjoyed at the Universal Studio. This company has most graciously consented to demonstrate the complete operation of making a motion picture from the breaking down of the scenario, making of sketches for sets, models, dubbing of pictures, adding sound effects, demonstrations by various artists, etc., to the final showing of the complete picture. This will be a rare opportunity to learn of the intricacies of picture making.

"S. S. VIRGINIA" IN PEDRO MIGUEL LOCK

Friday Afternoon and Evening

To the extensive Douglas Airplane Plant or, if desired, a trip up Mt. Wilson and an inspection of the many items of interest connected with the Observatory.

Friday evening will terminate the week's activities with a banquet at the Biltmore, with President Davis and Past-President Durand as the speakers on that occasion. After the dinner, dancing will be enjoyed in the famous Biltmore Bowl.

Women's Program

Wednesday

Informal get-acquainted luncheon at the Biltmore.

In the afternoon a trip will be made by bus to the famous Huntington Library where the priceless collection of books, pictures, and art treasures will prove of interest, and the extensive gardens will be enjoyed. The trip will be continued through the Orange Groves and the foothill towns to quaint Padua Hills Theater, where dinner will be served and a Mexican play presented. This will be a unique experience as the Mexican boys and girls serving the tables have rare ability in presenting their native songs and dances.

Thursday

Lunch will be served in Hollywood at the charming "Little-Bit-of-Sweden" Café. The men will also be welcome.

As the regular motion-picture program for this afternoon and evening is so attractive, no other entertainment has been planned for Thursday afternoon and evening.

Friday

Luncheon at the "Assistance League" in Hollywood where the stars are often seen in make-up and costume. A spring fashion show will be given, modeled by Los Angeles Society girls. The gift shop and art exhibit will also be of interest. In the afternoon, the women can join the men in the inspection trip of the Douglas plant, or may enjoy an auto trip through Hollywood, Beverly Hills, the motion-picture residence section, Hollywood Bowl, and the Beach Cities.

Technical Program for Los Angeles Meeting

Headquarters, Hotel Biltmore

WEDNESDAY, MARCH 23

9:30 a.m.

Hydraulic

Centrifugal Pumps for the Colorado River Aqueduct, by R. L. Daugherty

Cavitation of Centrifugal Pumps, by G. F. Wislicenus, R. M. Watson, and I. J. Karassik

Petroleum

Problems in Modern Deep-Well Drilling, by Robert L. Keyes

Problems in Modern Deep-Well Pumping, by C. J. Coberly

Process Industries

Pressure-Type Thermometer Systems, by L. G. Bean

8:00 p.m.

Hydraulic

Erosion of Impulse-Wheel Needle Nozzles, by A. Tenot

Modern Turbine Governing, by E. E. Woodward

Petroleum

Santa Maria and Summit Pump Station, by Fritz Karge

Fundamentals of Design of Cracking Furnaces, by J. W. Rickerman, W. Lobo, and A. L. Baker

General

System Frequency Change From 50 to 60 Cycles, by C. O. West

Heat-Transfer Research at University of California, by L. M. K. Boelter

THURSDAY, MARCH 24

9:30 a.m.

Hydraulic

Kaplan Turbines at Bonneville, by P. L. Heslop and G. A. Jessop

Spillway Gates at Bonneville, by E. B. Miller

Fuels

The Technique of Burning Fuel Oil and Natural Gas, by F. G. Philo

Combination Oil-and-Gas Burners, by O. F. Campbell

Aeronautic

Hydraulic Press Methods—Guerin Process, by Henry E. Guerin

Study of Dynamic Relations Between Moving Load and Structure, by R. K. Bernhard

Flight Velocity for Maximum Profit in Air Transportation, by Charles McLellan

Management

Scientific Management in Light of Present-Day Conditions, by King Hathaway

Leadership, by A. C. Galbraith

FRIDAY, MARCH 25

9:30 a.m.

Hydraulic

University of California Pump-Testing Laboratory, by R. G. Folsom

Hydraulic Jump in Slope Channels, by B. A. Bakhmeteff and A. E. Matzke

Applied Mechanics

A New Relationship for Use in Design of Machine Columns, by W. H. Clapp

Fluid Problems of Ocean Circulation, by H. U. Sverdrup

General

Mechanical Problems in Design of Diesel Tractors, by C. G. A. Rosen

Mechanical Problems of the 200-In. Telescope, by Michael Karelitz

Actions of A.S.M.E. Executive Committee

AT ITS meeting at Society headquarters, on Jan. 10, 1938, the Executive Committee of The American Society of Mechanical Engineers discussed a number of matters of general interest. Present at the meeting were Harvey N. Davis, chairman; Kenneth H. Condit, Harte Cooke, James W. Parker, and James M. Todd, of the Committee; K. M. Irwin (Finance), Crosby Field (Professional Divisions), J. N. Landis (Local Sections), advisory members; W. D. Ennis, treasurer; and C. E. Davies, secretary. During the afternoon, by invitation, there were also present E. J. Kates, chairman, M. J. Reed, secretary, and L. H. Morrison, member, of the executive committee of the A.S.M.E. Oil and Gas Power Division.

14 Fellows Elected

The poll of the council ballot revealed that the following were elected to the fellow grade of membership in the Society: Karl Arnstein, William L. DeBaufre, Francis W. Dean, W. Lyle Dudley, Alexander N. Engbloom, Gustave Fast, Crosby Field, George E. Hulse, George L. Knight, Henry A. Lardner, Howard B. Lawrence, Stewart M. Marshall, Kingsley L. Martin, and David E. Ross.

Future Meeting Approved

It was voted to approve holding of the 1938 National Fall Meeting of the Society at Providence, R. I., Oct. 5 to 7, 1938; and the 1939 Semi-Annual Meeting at San Francisco, Calif., during the week of July 10, 1938.

It was also voted to hold the Oil and Gas Power meeting at Dallas, Texas, June 15 to 18, 1938, and to invite participation of the Diesel Activities Committee of the Society of Automotive Engineers in this meeting.

An invitation to appoint two delegates to the International Engineering Congress, Glasgow, Scotland, June 21 to 24, 1938, was accepted. The Congress is to be held in connection with the British Empire Exhibition, and the president of the Congress is the Right Honorable Lord Weir, honorary member, A.S.M.E.

Because of the holding, in Cambridge, Mass., in September, 1938, of the International Congress of Applied Mechanics, the A.S.M.E. Applied Mechanics Division voted at the December meeting of its executive committee not to hold its customary national meeting but to cooperate with the Congress. Approval of this plan of cooperation of the Division was voted by the Executive Committee of the Council.

Program for 1938

At its December meeting the Executive Committee decided that it would discuss at each future meeting some important Society problem. For the meeting of January 10 the subjects discussed were "Special Interests of the Member in the National Society and in the Section," and "Technical Interests of the Society."

In discussion of the first subject, James W. Parker traced the history of local-section development and reviewed the contributions that have been made to the Society by the Sections. He called attention to the point of view sometimes held that the Society is merely a federation of local sections and said that it is desirable to stress the fact that the strength of the Society lies essentially in its national character.

Messrs. Kates, Reed, and Morrison joined in the discussion of the second subject which was made specific by pointing it to the problems of the Oil and Gas Power Division. The point of view and needs of the division were brought out, and the application, in general, of the principles involved as they related to the Society as a whole were discussed.

Machine Shop Practice Division to Meet at Rochester in May

THE PROGRAM which the A.S.M.E. Machine Shop Practice Division is planning for its meeting in Rochester, N. Y., May 10–12, is well advanced with many of the sessions entirely arranged.

Among these are the session at which papers are to be given on the industrial application of spiral bevel and hypoid gears and a new method of producing screw-machine products; and the session on foundry metals with papers on steel, gray-iron, and malleable-iron castings.

Other sessions are planned on methods, with papers covering trends in shop practice and drafting and what's new in electrical equipment for manufacturing operations.

Two evening sessions are being arranged dealing with inspection procedure and apprentice training, while details of several exceedingly interesting plant visits are now being planned.

More detailed facts concerning papers, authors, speakers, and trips will appear in later issues.

The A.S.M.E. Nominating Committee Solicits Suggestions for Nominees for Office in 1939

Preferably Not Later Than May 1

THE 1938 Nominating Committee of The American Society of Mechanical Engineers requests the members of the Society to give serious consideration to the selection of nominees for elective offices in 1939 and to submit their suggestions promptly, preferably not later than May 1.

Complete Record Necessary

In order that a candidate may receive the fullest consideration, his sponsor should submit a complete biographical and professional record, and a list of the activities in which he has been engaged within the Society, as well as in other professional and nonprofessional organizations. The candidate's sponsor should also obtain assurance that he will serve if elected.

Officers should be men of prominence and leadership with time to devote to Society affairs. Previous service on committees and knowledge of Society affairs is a factor of importance. The president and vice-presidents must be of the member or fellow grade; managers may be of any grade of membership.

The work of the Committee will be greatly expedited if seven copies of each proposal are submitted to any members of the Committee as listed:

Members of the Committee

GROUP I: T. H. Beard, representative, Dictaphone Corp., 375 Howard Ave., Bridgeport, Conn.; W. L. Edel, alternate, Conn. State College, Storrs, Conn.

GROUP II: F. M. Gibson, *chairman*, representative, American Sugar Refining Co., 49 S. 2nd St., Brooklyn, N. Y.; T. Baumeister, Jr., alternate, Columbia University, New York, N. Y.

GROUP III: H. L. Whittemore, representative, National Bureau of Standards, 3906 McKinley St., N. W., Washington, D. C.; G. E. Crofoot, alternate, University of Pennsylvania, 33rd and Locust St., Philadelphia, Pa.

GROUP IV: F. L. Wilkinson, *secretary*, representative, University of Tennessee, Estabrook Hall, Knoxville, Tenn.; R. M. Rothgeb, alternate, Budget Bureau, Raleigh, N. C.

GROUP V: H. C. Anderson, representative, University of Michigan, Ann Arbor, Mich.; James Burke, first alternate, Burke Electric Co., Erie, Pa.; F. C. Hockema, second alternate, Purdue University, West Lafayette, Ind.

GROUP VI: R. M. Boyles, representative, 525 International Bldg., St. Louis, Mo.; E. H. Sager, alternate, Washington University, St. Louis, Mo.

GROUP VII: G. L. Sullivan, representative, University of Santa Clara, Santa Clara, Calif.; H. J. Smith, first alternate, Pacific Gas and Electric Co., 245 Market St., San Francisco, Calif.; H. B. Langille, second alternate, University of California, Berkeley, Calif.

Crosby Field Elected President of A.S.R.E.

DURING the annual meeting of the American Society of Refrigerating Engineers in New York, January, 1938, Crosby Field, life member, A.S.M.E., was elected and installed as president for the year 1938. Gardner Poole and C. T. Baker of Chicago became vice-presidents and George E. Hulse, member, A.S.M.E., was chosen treasurer. David L. Fiske was reelected as executive secretary.

Proceedings of Oil and Gas Power Division 1937 Meeting Now Ready

Available to Members at Two Dollars a Copy

A LIMITED number of copies of the proceedings of the Oil and Gas Power Division Meeting held last August at State College, Pa., are available to members of the A.S.M.E. at $2 a copy. These copies, prepared in photo-offset form, contain the papers and discussions presented at that meeting as follows:

Progress Reports, by Diesel-engine manufacturers and locomotive builders[1]
The U. S. Navy Contribution to Diesel Engine Development, by E. C. Magdeburger
Lubrication Problems in Connection With High-Speed Diesel Engines, by C. G. A. Rison
Sewerage Gas Engines,[1] by W. B. Walraven
Oil Flow Through Fuel Nozzles,[1] by K. J. DeJuhasz
Polymerization of Fuel Oils, by Gustav Egloff
Waste-Heat Recovery From Diesel Engines,[1] by Glenn C. Boyer
Correlation of Laboratory Tests on Fuel Oils With Field Operation,[1] by W. F. Joachim
Recent Developments in Automotive-Type Diesel Engines, by O. D. Treiber
Some Operating and Upkeep Costs for Diesel Locomotives, by J. W. Anderson, Consulting Engineer
Diesel-Electric Bus Operation, by Martin Schreiber
Penn State Method of Testing Diesel Fuels,[1] by J. S. Chandler.

There is also available to members a limited number of copies of the Oil-Engine Power Test Code for 1936, at $0.80 a copy.

All requests, either for the proceedings, individual papers, or the Oil-Engine Cost Report for 1936, must be accompanied by the proper remittance. Such requests should be addressed to the A.S.M.E. Oil and Gas Power Division, 29 West 39th St., New York, N. Y.

[1] Additional copies of this paper may be obtained at $0.25 a copy or five copies for $1.

Dean Cooley Receives His B.S. Degree From Annapolis

Conferred by Act of Congress

MORTIMER E. COOLEY, past-president, A.S.M.E., was the recipient just recently of the degree of bachelor of science from the United States Naval Academy. The many who know Dean Cooley may be surprised at this announcement and gain the impression that the Dean has become an undergraduate again at the age of 82.

He really "was graduated" sixty years ago, but it was only quite recently that Congress passed an act authorizing the superintendent of the Naval Academy to confer "upon all living graduates who may be recommended for such award" the degree certificate which other institutions of higher learning customarily have bestowed. The beloved Dean, who holds several advanced degrees and has been honored in so many other ways, had quite a chuckle at finally receiving his baccalaureate degree.

Courtesy the Michigan Alumnus

CADET ENGINEER M. E. COOLEY, AGE 23, AT THE U. S. NAVAL ACADEMY, ANNAPOLIS

Another interesting feature about the story is that his son, Hollis M. Cooley, was graduated from the Academy in 1906 and his grandson, Hollis W. Cooley, was graduated in 1936. This young man received his B.S. at the time of his graduation. Later the father, Captain Cooley, was awarded his B.S. and now the grandfather, Dean Cooley. Thus the first in that family to be graduated was last, and the last was first, to receive his degree.

[In this connection the readers' attention is called to a most appealing story written by Dean Cooley in the February, 1938, issue of *Civil Engineering*, "From Farmer Boy to College Dean."—EDITOR.]

Second Trip Itinerary of President Harvey N. Davis

Mar. 7: St. Louis Section
Washington Univ. Student Branch

Mar. 8: Mid-Continent Section
Univ. of Arkansas Student Branch

Mar. 9: South Texas Section
Rice Inst. Student Branch

Mar. 10: Texas A. & M. Student Branch

Mar. 11: University of Texas Student Branch

Mar. 12: San Antonio Group

Mar. 14: North Texas Section
Southern Methodist University Student Branch

Mar. 15: Texas Tech Student Branch

Mar. 17: Univ. of New Mexico Student Branch

Mar. 18: Univ. of Arizona Student Branch

Mar. 19 to 26 Los Angeles Spring Meeting

Mar. 28: Stanford Univ. & Univ. of Santa Clara Student Branches

Mar. 29: Univ. of California Student Branch

Mar. 30: San Francisco Section

Apr. 1: Oregon Section
Oregon State Agricultural College Student Branch

Textile Papers Available to A.S.M.E. Members

RECENT developments in wet-finishing and dyeing machinery were described by Paul A. Merriam at the Textile Division meeting that was held in Boston on Oct. 15, 1937. His paper deals briefly with the introduction of the range or continuous method and the application of stainless steel to the machinery used for fulling, washing, and dyeing woolen and worsted piece goods.

At the textile-printing symposium that was part of the 1937 Annual Meeting, Wallace Taylor contributed a paper, "Mechanical Equipment for Fabric Printing." After pointing out that several of the original textile-printing machines are still in operation after 75 years of service, the author describes some improvements that have recently been made. These include a variable-speed motor drive with special controls to give printing speeds ranging from 20 to 100 yd per min, improved printing-roll construction using antifriction bearings, soaping and washing machines with individual motor drive for each set of nip rolls, and drying machines having all-welded stainless-steel cylinders that operate at higher speeds because they are equipped with individual syphons, packless joints, and ball- or roller-bearing journals.

Both papers have been mailed to members of the Textile Division. Other members can secure copies of the individual papers without charge, while the supply lasts, upon application to the Secretary, The American Society of Mechanical Engineers, New York, N. Y.

Distribution of Pages Devoted to Papers Sponsored by A.S.M.E. Professional Divisions

In "Mechanical Engineering" and "Transactions" January, 1936, to October, 1937

AT THE Erie meeting of the Executive Committee of the Council of The American Society of Mechanical Engineers it was suggested that a study be made of the relative amounts of space that have been devoted recently in MECHANICAL ENGINEERING and the Transactions to the papers of the various divisions, and that the figures obtained be compared with the percentages of member interest in the corresponding divisions.

The editorial staff has made a study of MECHANICAL ENGINEERING and Transactions from January, 1936, to October, 1937, inclusive and has prepared the following table showing these two sets of percentages. The "members' first choice of division interest, 1935, per cent" (column 2 of the table) is based on returns from members answering 1935 professional data questionnaire (50 per cent of 1935 membership).

COMPARISON OF PAGES OF PUBLISHED PAPERS SPONSORED BY DIVISIONS AND MEMBERS' FIRST CHOICE OF DIVISION INTEREST

Division	Pages devoted to paper and discussion, per cent of total	Members' first choice of division interest, 1935, per cent	Remarks
Aeronautic	5.71	4.55	
Applied Mechanics	16.1	8.88	See note (3)
Fuels and Steam Power	22.8	22.9	See note (1)
Hydraulic	11.9	4.39	See note (2)
Iron and Steel	4.72	3.26	
Machine Shop Practice	8.72	10.91	See note (6)
Materials Handling	0.72	1.55	
Management	6.12	21.7	See note (4)
Oil and Gas Power	4.41	4.05	See note (7)
Graphic Arts	0.21	1.31	See note (5)
Process Industries	12.3	9.14	See note (2)
Railroad	7.05	2.36	See note (2)
Textile	1.03	1.20	
Wood Industries	0.98	0.84	
Petroleum	2.23	2.96	
Total (1925 pages)	100.00	100.00	

NOTES:

In reading the table the following factors should be kept in mind:

(1) Only papers directly sponsored by Divisions have been counted. There are many papers (and abstracts) of interest to the divisions that have not been taken into account. For example: 19 pages contributed by the Safety Committee; 240 contributed by the Research Committee; 5 by the Power Test Codes Committee. Articles contributed by local sections are omitted, as are all other general articles (addresses), survey abstracts, and similar material. A breakdown of this material would change the percentages and would require an extended study. It would be difficult to assign some papers specifically to any one division and others (like research) might be assigned to several divisions if interest in subject matter were taken as a criterion.

(2) Divisional activities wax and wane as personnel of committees changes and as technological developments increase or decrease. For example, there is great interest in hydraulics at present, and also in railroads. The Process Industries Division is young and lusty, its literature has been neglected by the Society, and developments in it are active.

(3) The Applied Mechanics Division has collected money from industry and universities to finance a part of its publications. It also publishes book reviews, which are included in the tabulation.

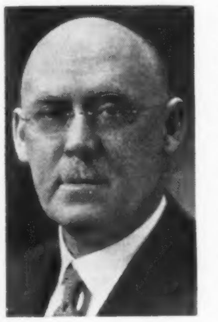
(4) Much of the material in MECHANICAL ENGINEERING not directly sponsored by the Management Division bears directly on its interests.

(5) Proceedings of the Graphic Arts Conferences are published separately and distributed to members of the Division.

(6) Many of the research papers published are devoted to the cutting of metals, of direct interest to the Machine Shop Practice Division, but sponsored by the Research Committee.

(7) The Oil and Gas Power Division preprints papers for its national meetings and distributes them in mimeograph form. Some of these are later published in MECHANICAL ENGINEERING or Transactions.

W. N. Barnard Named Director of Sibley School at Cornell



W. N. BARNARD

HAVING been acting director of the Sibley School of Mechanical Engineering in the College of Engineering of Cornell University for the last year and a half, Prof. William N. Barnard was recently named director of the Sibley School by the board of trustees of the University. Professor Barnard, a graduate of Cornell in 1897, has been, with the exception of two brief periods, a member of the faculty ever since. In 1907, he was appointed professor of heat-power engineering and for the last eighteen years has been head of the department.

He has been associated with the A.S.M.E. for the last 38 years. The textbook, "Heat-Power Engineering," of which Professor Barnard was coauthor with Prof. F. O. Ellenwood and C. F. Hirshfeld, is used in forty-three engineering schools. Earlier he wrote with Hirshfeld, "Elements of Heat-Power Engineering," and in 1917 published a text on valve gears.

A.S.M.E. Woman's Auxiliary Installs New Officers

Reviews Loan-Fund Activities at February Meeting

MEETING on January 13 at headquarters, the Woman's Auxiliary to the A.S.M.E. installed the following new officers for 1938: Mrs. G. W. Farny, president; Mrs. J. Ansel Brooks, Mrs. Calvin W. Rice, and Mrs. R. T. Kent, vice-presidents; Mrs. C. E. Gus, recording secretary; Mrs. J. N. Landis, corresponding secretary; and Mrs. A. H. Morgan, treasurer. Mrs. Farny appointed the following committee chairmen: Mrs. P. E. Frank, courtesy; Mrs. R. V. Wright, educational; Mrs. C. G. Gulbrandsen, hospitality; Mrs. R. B. Purdy, membership; Mrs. J. H. R. Arms, program; Miss Burtie Haar, publicity; and Mrs. F. M. Gibson, ways and means.

At the February meeting, held in the Engineering Woman's Club, the Education Committee, consisting of Mrs. R. V. Wright, chairman, Mrs. W. H. Boehm, Mrs. A. D. Blake, Mrs. J. A. Brooks, Mrs. H. V. Coes, Mrs. C. W. Rice, and Mrs. A. H. Morgan, presented the 1937 report on the Student Loan Fund, which today amounts to \$5994.67. Thus far loans of \$8944.02 have been made to 38 students in fifteen schools, refunds total \$3280.00, unpaid interest comes to \$206.39, and loans outstanding total \$5663.51.

Tri-Cities Section a Sponsor of Management Conference at Iowa City, April 8

Joins With College of Engineering at University of Iowa, and Iowa Manufacturers Association in Comprehensive Program

ARRANGEMENTS have been completed for a Management Conference, devoted to the consideration of method of wage payment and motion and time study, to be held at Iowa City, Iowa, on Friday, April 8, 1938. This Conference is sponsored by the Tri-Cities Section of the A.S.M.E., the College of Engineering of the University of Iowa, and the Iowa Manufacturers Association.

The program for the conference follows:

9:30 a.m.

The Payment of Wages

Evaluation of Occupations and the Factors Involved in Setting Base Rates, by Ralph H. Landes

The Application of a Wage Incentive System, by J. K. Louden

1:15 p.m.

Motion and Time Study

The Application of Motion and Time Principles in the Laundry Industry, by W. A. Reinhard

A Training Program in Principles of Motion Economy, by L. P. Persing

Some Practical Applications of Motion Study Research, by Ralph M. Barnes

4:00 p.m.

Skills and Satisfactions

Lecture by Lillian M. Gilbreth

Following this session those interested will have an opportunity to visit the University of Iowa Motion and Time-Study Laboratory

6:15 p.m.

Dinner

Toastmaster, Prof. H. O. Croft

Address by Eugene A. Gilmore, President of the University of Iowa

Selling a Work Simplification Program to Management and Men, by Allan H. Mogensen

Committee in Charge

Members of the committee in charge of arranging the Conference are Ralph M. Barnes, Member A.S.M.E., chairman, and professor of industrial engineering at the University of Iowa; Charles A. Carson, secretary-treasurer of the A.S.M.E. Tri-Cities Local Section and connected with the John Deere Plow Works in Moline, Ill.; and Edward A. Kimball, manager of the Iowa Manufacturers Association, Des Moines, Iowa.

Other Local Sections News

Akron-Canton Section

Prof. Fred S. Griffin announced to the student members of the University of Akron Student Branch that the Akron-Canton Section had offered prizes for the best two papers presented by the students.

Anthracite-Lehigh Valley Section

Meeting in Reading, Pa., January 28, 75 members and visitors listened to a talk by William A. Shoudy, past vice-president, A.S.M.E., on small boiler equipment in which, with the aid of slides, he described the latest developments, compared the different types, and discussed the use of anthracite coal.

Baltimore Section

On February 10, R. S. Carter, Goodyear Tire & Rubber Co., discussed the new uses for rubber products, including the many applications to machines.

Birmingham Section

A symposium on the mechanics of the cupola and its auxiliary equipment was the general subject of the joint meeting of the Birmingham Section of the A.S.M.E. and the American Foundrymen's Association on February 24 and 25. At a joint session with the local section of the A.I.E.E., January 21, Prof. J. M. Gallalee, member, A.S.M.E., described the progress in the design and performance of internal-combustion engines.

Boston Section

Recent developments in the field of steam power was the subject of the paper presented on February 17, by E. G. Bailey, member, A.S.M.E., and vice-president of Babcock & Wilcox Co. At the same meeting, Frederick W. Bliss talked on "Industrial Modernization."

Buffalo Section

Military aviation, its problems and progress, was the topic discussed by Lawrence D. Bell, president, Bell Aircraft Corporation, at a meeting on January 18. The annual dinner dance of the section was held on Friday evening, February 11, at the Park Lane. As usual, favors were provided for the ladies.

Central Pennsylvania Section

At State College, Pa., Maxwell C. Maxwell presented his talk on "Loxology" on January 18, and his paper on material handling on January 19. Approximately 130 members turned out for the two meetings.

Chicago Section

The Power and Fuels Division had Dr. H. F. Yancey, University of Washington, present a paper on February 8 on the subject, "Comparisons of Grindability Standards." He showed how the measure of a coal's grindability is of vital importance to the economic design of power plants contemplating the use of pulverized fuels.

Cincinnati Section

To open the evening's entertainment at the stag smoker held in the Engineers' Club on January 13, Dr. Gustave Eckstein gave an interesting discussion of his experiences during a recent trip to Russia. Entirely different from the customary programs, Doctor Eckstein's talk gave members an unusual insight into a field seldom encountered by engineers.

Cleveland Section

A joint meeting with the National Association of Cost Accountants was addressed by Allan H. Mogensen, member, A.S.M.E., on the subject of "Plant Layout." The economics of plant layout was discussed and many examples were shown of the savings which can be effected through efficient layout.

Colorado Section

Meeting at the Parisienne Rotisserie in Denver on January 28, the members made it an occasion to present a life membership in the Society to L. D. Crain. Following this ceremony, Joseph L. Singleton, Allis Chalmers Mfg. Co., with the aid of slides, showed the trend in condenser design and discussed methods of suspension.

Dayton Section

Since there is no recognized student branch of the Society at the University of Dayton, the Dayton Section has encouraged the students to present papers at meetings sponsored by it. Such a meeting was held on February 17, at which the following students talked: D. P. McCrate, Wm. M. Schroeder, B. F. Hollenkamp, J. M. Leonard, and L. J. Darbier.

Detroit Section

Talking on the development in the design and use of gaging equipment, C. V. Johnson, member, A.S.M.E., at a meeting held on February 15, related many of his personal experiences which were gained as a result of his association with the Pratt & Whitney Division of the Niles-Bement-Pond Co.

Hartford Section

Meeting on January 14 at The Endee Club in Bristol, Conn., members and invited guests had the extraordinary pleasure of welcoming and listening to Dr. E. J. Abbott, member, A.S.M.E., who had come all the way from Ann Arbor, Mich., to present a paper on the "Profilometer for the Rapid Measurement of Surface Roughness," which he had presented at the 1937 Annual Meeting of the Society. This paper appears in this issue, pages 205–216.

Kansas City Section

With Linn Helander presiding, a meeting was held on January 12 at which Dean R. A. Seaton spoke on the evolution of mechanical-engineering curricula and the accrediting activity of E.C.P.D. Then E. E. Howard told of some of his experiences in visiting schools and made a plea for placing more emphasis on basic courses and less on specialized subjects. A general discussion, opened by Prof. R. W. Selvidge, followed.

Los Angeles Section

The January meeting of the section held on January 19, was a dinner meeting attended by 125 members. The first paper by Aladar Hollander, member, A.S.M.E., described the development of a centrifugal pump with a submersible motor, designed by him, and developed commercially for irrigation service. The second paper by Prof. F. C. Lindvall, discussed the development of a new type of railroad passenger car which compared with a standard car is 36 in. less in over-all height, 16 in. less in floor height, 5 in. wider inside, and 35,000 lb less in total weight. The body of monocoque construction is suspended on coil-compression springs enclosed in bulkheads at the ends of the car, thus enabling the points of suspension to be well above the center of gravity.

Metropolitan Section

On Friday evening, February 4, the German Language Group held a technical meeting at which Siegfried Ruppright, consulting engineer, explained a method of "Indicating the Air Condition," using slides and an instrument for illustration. After giving a synopsis of the talk in English for the benefit of the many visitors, the speaker delivered his paper in German, speaking slowly so that all could understand it.

Mid-Continent Section

Drawing from his own experiences, H. M. Cooley in a talk at a luncheon meeting in Tulsa, Okla., described the Poza Rica oil fields in Mexico, drilling methods, transportation, welding practices, labor conditions, and government policies.

Minnesota Section

After describing the training program at Dunwoody Institute of which he is director, Dr. C. A. Prosser, at a meeting held at the University of Minnesota on January 27, stressed the need for special training so that the needs of industry for high-grade machinists and mechanics might be met.

Nebraska Section

An hour's talk on the difficulties experienced with a 1250-lb per sq in. power plant, was given by Fred Turner, Nebraska Power Co., at a joint A.S.M.E.-A.I.E.E. meeting held in Omaha on February 2.

New Haven Section

At Yale University, January 18, members learned about the design of nonferrous castings and their alloy specifications from S. B. Dianna and G. R. Holmes, member, A.S.M.E.

North Texas Section

During the regular meeting held in Dallas, two members of the section presented papers. Thomas S. Bacon discussed the unique design and operation of a natural-gas purification and dehydration plant recently constructed, and J. Woodward Martin spoke on the subject, "Making Natural-Gas Service Available for Rural Customers Through Butane."

Norwich Section

Meeting at the Allyn Museum in New London, Conn., January 28, forty-two members and guests heard Frank O. Hoagland, vice-president, A.S.M.E., discuss the economical and practical aspects of the modifications introduced through the use of American standards. After the lecture, the audience was given an opportunity to inspect a display of gages and machine-tool literature.

Ontario Section

Following a dinner held in the Great Hall of the University of Toronto, members met on February 10, to listen to Frederick E. Searle, superintendent of the Henry Ford Trade School in Dearborn, Mich., talk on the subject, "Training of Youth for Industry." His remarks included a description of the progressive and successful methods of employee training developed and practiced under his supervision by the Ford industries.

Peoria Section

"Administration and Management" was the title of the paper presented by T. S. McEwan, member, A.S.M.E., at a meeting held on January 20. Stating that successful management depends on executives keeping in continual touch with the major divisions of their business, he showed with the aid of charts and illustrations how an engineer through study can correct mismanagement and coordinate administration and management. A royal reception was given to Dr. Harvey N. Davis on the occasion of his visit on January 27 by the 40 members and 110 visitors who were present.

Philadelphia Section

On January 25, the monthly meeting of the section was held and addressed by Channing Rice Dooley, manager of industrial relations, Socony-Vacuum Co., Inc. There was an attendance of nearly 100 at the meeting. The discussion following the presentation of the paper on "Management" lasted more than an hour and a half.

Plainfield Section

J. P. Den Hartog, associate professor at Harvard University and member, A.S.M.E., on January 26, gave a lecture in which he demonstrated the use of models to illustrate complicated mechanical problems, such as vibrations in machinery.

Providence Section

Touching briefly on some of the new devices developed in the machine-tool industry, Tell Berna, at the February meeting, told of the relationship between the industry and the general economic situation. He showed the

need of new machine tools in shops, estimating that 61 per cent of tools now in use are obsolete.

Puerto Rico Group

On his cruise in the Caribbean in the early part of January, William A. Shoudy, past vice-president, A.S.M.E., stopped at San Juan on January 11, to visit the University of Puerto Rico Student Branch. Because of the little time available and a distance of 240 miles to and from the University, Mr. Shoudy was unable to fulfill his engagement. However, members of the society living in Puerto Rico, led by Prof. Ramon I. Gil, met and took him on a visit to some of the nearby industrial plants and then to a luncheon attended by twenty-two engineers. According to Mr. Shoudy, the members are doing some fine work and rendering real public service, thus bringing credit and honor to the profession.

Raleigh Section

Addressing a morning meeting at North Carolina State College on January 29, Eugene W. O'Brien, past vice-president, A.S.M.E., outlined the purposes of the society as follows:

(1) Spreading of engineering knowledge
(2) Writing of papers
(3) Raising the standards of the profession
(4) Making acquaintances through activities in the Society

Other guests included W. E. McDowell, member, A.S.M.E., Alfred Bollenback, chairman of the Charlotte Section of the A.S.M.E., and the officers of the North Carolina State College Student Branch.

Rochester Section

A paper illustrated with a talking motion picture was presented on January 20, by Ray E. Herbert, Johns-Manville Co., on the subject, "Heat and Its Control."

Utah Section

On Monday morning, January 24, *The Salt Lake Tribune* carried a half-page announcement illustrated with photographs of a technical meeting sponsored by the section for January 29, as a part of the dedication ceremonies of the D.&R.G.W. Railroad's new power plant. According to a later report received from W. H. Trask, Jr., chairman of the section, the meeting which followed the inspection of the new equipment was addressed by Durbin Van Law, member, A.S.M.E., who was in charge of construction. A discussion of the mechanical aspects was conducted by Prof. E. H. Beckstrand, Ralph Baker, and Julius Billeter, all members of the A.S.M.E. Guests at the meeting included members of the Utah Society of Professional Engineers, A.S.C.E., A.I.E.E., and the American Association of Power Engineers.

San Francisco Section

Under the auspices of the San Francisco Engineering Council, a joint meeting was held on January 12, of the local sections of the four Founder Societies, A.S.H.&V.E., and the S.F. Air Conditioning Society, at which Prof. Baldwin M. Woods, member, A.S.M.E., discussed "The Human Element in Air Conditioning." He pointed out the natural air-conditioning elements in the human body and mentioned experiments in wall heating carried on by the General Electric Co. and the Westinghouse Co. in the United States and in ceiling heating by Sulzer Brothers in Europe. During the discussion which followed, Dr. Matthew Hosmer of the S. F. Medical Society, mentioned that air-conditioning systems in offices and homes prevent the spreading of colds. Prof. Walter Weeks of the University of California, described installations in mines. More than 250 engineers attended the meeting.

St. Louis Section

Illustrating his talk with slides and motion pictures, R. F. Flood, Chicago engineer, Linde Air Products Co., on January 28, told of oxyacetylene cutting and treating processes and their application to welded fabrication.

South Texas Section

A motion picture of the construction of Boulder Dam was presented at a meeting at Rice Institute on January 28.

Syracuse Section

The design and development of a 50-hp air-cooled aviation engine by E. S. Marks, Doman, Marks Engine Co., was described by him at a session held on January 27.

Waterbury Section

About 110 members and guests attended the January 19, meeting at which A. C. Curtiss of the Scovill Co., discussed the business side of the labor question, and Frank Rising, labor editor of *Business Week*, presented his views based on personal observations.

Western Washington Section

An audience consisting of 75 members and their ladies viewed the motion picture, "Heat and Its Control," and listened to a reading by B. Cruikshank on the ethics of the engineering profession at the monthly meeting on January 18.

West Virginia Section

Thirty-two members attended the dinner given in honor of President Davis on his visit on January 18, and more than one hundred listened to his address, "The Engineer of the Future," at the meeting which followed.

Worcester Section

Meeting on January 11, the members heard a talk by William Livingston, Alexander Hamilton Institute, on business analysis and economic trends.

Junior Group Activities

35th Junior Group Formed in New Orleans

TO PROMOTE closer cooperation between Juniors and other members, and to establish a closer relationship between student members and the Society, a Junior Group has been organized by the New Orleans Section. This new group under the chairmanship of A. de R. Remanjon, brings the number of such organizations to 35.

Thirty Junior Members Visit Cleveland Airport

IN SPITE of inclement weather, thirty members of the Cleveland Junior Group made an inspection tour of the Cleveland Airport on Wednesday evening, January 26. This is one of the largest municipal airports in the world, and likewise one of the most modernly equipped commercial flying fields.

In the offices of the U. S. Weather Bureau, Department of Agriculture, the group saw the collection of weather data, its analysis, and the distribution of forecasts. Closely linked with this office is the teletype office of the Department of Commerce where weather and traffic reports are received and sent on by relay. Another vital part of the airport management system, in which great interest was displayed, is the control tower which handles all traffic, giving, by radio, instructions and information needed by the pilots in approaching the field and leaving it.

Of engineering interest is the floodlight of the carbon-arc type which is rated at 500 million candlepower. Standing at the opposite side of the field, one and one-half miles distant, one can read a newspaper by its light. An auxiliary incandescent bulb automatically advances into the focal position to replace the carbon arc, in the event of its failure.

The United Air Lines hangar visited by the juniors is 200 ft long and 100 ft wide, with but one central column supporting the roof. A Boeing transport plane, in United service, was examined from stem to stern, as was a 10-passenger Douglass in the American Airlines hangar.

Baltimore Juniors Hear Talks on Gas Welding

THE JUNIOR Group of the Baltimore Section held its first meeting of the new year on January 25, at Johns Hopkins University. J. H. Berryman of the Bethlehem Steel Company and M. G. Wicker of the Air Reduction Sales Company presented a two-part discussion of oxyacetylene welding. The relationship between the foreman and the welder regarding welding and welding design was the

subject of the first part. In the second half, the fundamental principles of oxyacetylene welding were considered and a short outline of the history of its development was given. A welding demonstration, given by W. M. Lyon of the Air Reduction Sales Company, illustrated the "puddle," "back," and "forehand" types of welding as related to plate, sheet, and pipe work.

The meeting was the first of a series planned by the executive committee; a series in which the papers will be coordinated for the purpose of making available to the members of the group information of a more concentrated nature.

A trip through the plant of the American Smelting and Refining Company was a December high spot, and the group hopes soon to inspect the Westport Steam Station of the Consolidated Gas and Electric Company of Baltimore.

Juniors Are Encouraged to Present More Papers

JUNIORS are always encouraged to present papers for consideration by the editor of the Society's publications. Emphasis will be laid on this fact by the executive and administrative committee of the Metropolitan Junior Group, according to an announcement by W. G. Hauswirth, chairman. The committee will sponsor a movement to the end that more juniors will take advantage of the opportunity offered to them to set forth the results of work done by young engineers.

This decision was made at the committee's February meeting at which the desirable features of more active junior participation in the presentation of written papers was discussed. Experience and professional prestige are gained by the writer, and the wider choice of papers available for publication benefits the entire Society.

Tanks and Air Conditioning Discussed at Meeting of Metro Juniors

THE NATIONAL-defense seminar of the Metropolitan Junior Group sponsored one of the principal February meetings of the Section, at which Prof. Carlos De Zafra, of New York University, discussed "Tanks and Tank Development." Motion pictures were employed in the presentation of the latest in tank construction.

The meeting was arranged in line with the policy of holding a major national-defense meeting each February, and the subject was selected because of widespread interest in this still relatively new weapon. Victor Wichum, chief engineer, research and development, C. J. Tagliabue Manufacturing Company, served as chairman, and arrangements were in charge of M. W. Deutschman, chairman of the national-defense seminar.

A talk on theater air-conditioning by Edwin Sternberg of the Armo Cooling and Ventilating Company, was the feature of the February program of the air-conditioning seminar of the Metropolitan Junior Group. The principles of the design of air-conditioning systems for theaters were thoroughly reviewed and illustrated with examples from the numerous installations designed by Mr. Sternberg. A lively discussion followed. Chairman for the meeting was Sam Shoor, and arrangements were in charge of Sidney Davidson.

Detroit Juniors Visit Newspaper Plant

THE JUNIOR Group of the Detroit Section, for its January meeting, held an inspection trip through the plant of the *Detroit Free Press*, one of Detroit's leading newspapers. Unusual interest was displayed since many of the group had never seen a modern newspaper plant in action.

In the composing room, the men saw the news stories divided into paragraphs for typesetting by individual operators and marveled at the speed with which a news column is completed. An interesting demonstration of the operation of a linotype machine was given by one of the operators. The casting of the plate actually used in printing the paper, and the making of the paper mold from the original flat page of type also held the interest of the visitors. Finally, an insight was gained into the far-flung machinery of the Associated Press and United Press services, which gather the news of the day for nationwide dissemination.

After the inspection, a short business meeting was held to discuss plans for the Annual Ladies' Night program, to be held in February.

South Texas Junior Group Commended by A. J. Kerr

ATTENDING a meeting of the Junior Group of the South Texas Section at Rice Institute, January 28, as a guest, A. J. Kerr, member of the Committee on Local Sections, in his report commends the group on their fine turnout and worth-while program, which included a showing of a motion picture on the construction of Boulder Dam. There were 30 Juniors present.

Cincinnati Junior Forum Holds Two Meetings

ENGINEER'S registration laws were the subject of a talk by Perry T. Ford, Secretary of the State Board of Registration of Professional Engineers, given before the January meeting of the Cincinnati Junior Forum, at the Cincinnati Club. The history, progress, and probable trend of these laws were outlined and the aims, purposes, and accomplishments of State registration so presented as to stimulate spirited discussion.

The speaker for the February meeting of the Forum was Dr. R. C. Gowdy of the University of Cincinnati, who took as his topic, "Atoms." The meeting was held February 7 at the Engineers' Club. Dr. Gowdy, in a manner at once scientific, popular, and fascinating, presented an account of the weird and almost incredible discoveries of recent investigations in the atomic field.

News of these meetings comes from "*The Cincinnati Engineer & Scientist*" an attractive monthly publication sponsored by the combined engineering societies of Cincinnati, and edited by Paul H. Goodell.

Wanted: Pictures for Junior Group News

JUNIORS are urged to contribute photographs suitable for publication in the Junior Group news of MECHANICAL ENGINEERING, in other words, for this page. Pictures of group chairmen and other officers and news shots showing group activities are particularly desired, but other photos of interest to the membership will be considered.

Such contributions should be plainly marked, giving names of individuals pictured and any other pertinent information. Address them to Louis N. Rowley Jr., or Leslie F. Zsuffa, care of MECHANICAL ENGINEERING, The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.

Ten Junior Members on Standing Committees

DURING the year 1938, ten Juniors are acting as advisory members to the several standing committees of the Society. The committees and the Junior members on them are as follows: *Meetings and Program*, W. W. Lawrence and H. G. Oliver, Jr.; *Publications*, A. E. Blirer and R. F. Warner, Jr.; *Professional Divisions*, Elmo Caruthers, Jr.; *Local Sections*, W. F. Carhart; *Constitution and By-Laws*, Carl Lindmeyer, Jr.; *Honors and Awards*, E. A. Hovner; *Relations With Colleges*, C. K. Holland; and *Power Test Codes*, John Allhusen. Since these members represent all of the Juniors in the A.S.M.E., it gives the younger members a medium through which to present any problems or suggestions to the various committees.

Help Wanted

DURING the annual meeting of the American Institute of Electrical Engineers in New York, Jan. 28, 1938, C. G. Suits, research physicist of the General Electric Research Laboratory was chosen as America's outstanding young electrical engineer for 1937. He was selected from a group of 60 candidates less than 35 years of age, submitted by leading industrialists and educators.

There are many young mechanical engineers doing similar outstanding work in their field. So that the Society may know of their accomplishments, you are requested to furnish us with the names of such young men together with a brief note about their work for publication.

With the Student Branches

President Davis to Visit Many Student Branches on Next Trip

Student Branches at Toronto and Marquette Promise Interesting Sessions

STARTING his second series of visits to local sections and student branches on March 6, 1938, Dr. Harvey N. Davis, president of the A.S.M.E., has planned to attend seven of the ten Student Meetings scheduled for 1938, and to visit the many student branches on his route.

On the way to the Spring Meeting in Los Angeles, President Davis will stop off to talk to members of student branches at Washington University, Arkansas, Southern Methodist, Texas A.&M., University of Texas, Rice Institute, Texas Tech, New Mexico, and Arizona.

Following the A.S.M.E. Spring Meeting in California, six student meetings, as shown elsewhere in this issue, and student branches at Stanford, Santa Clara, University of Washington, Idaho, Washington State, Montana, Wyoming, Wisconsin, Armour, Northwestern, and Illinois, will have the good fortune to hear Doctor Davis.

However, as they say in contracts, the above is subject to change, due to such unforseen incidents as floods, tornadoes, rain in California, etc. Headquarters, in the person of Ernest Hartford, assistant secretary and popular adviser of student branches, will notify each branch in plenty of time as to when to expect President Davis.

TORONTO TO GIVE MAN-MILES CUP

The Student Branch at the University of Toronto, which will be the host for the Group IV—Alleghanies Student Meeting, May 2 and 3, has planned an ambitious program, consisting of technical sessions, inspection trips, a banquet, and a dance. Furthermore, the Ontario Section of the A.S.M.E. has donated, through the branch, a "man-miles" cup for annual competition in Group IV, to be awarded to the branch which has the best representation at each Student Meeting with respect to men and miles traveled.

MARQUETTE PLANS "MILWAUKEE BEER PARTY"

With 17 student branches expected to take part in the Group V—Mid West Student Meeting in Milwaukee, April 18 and 19, Marquette Branch, host for the affair, promises, among many other things, visits to several breweries. A good old-fashioned "Milwaukee Beer Party" is being planned for the evening of the banquet.

A New Judging System for A.S.M.E. Student Group Conferences

AT THE Group I meeting of the A.S.M.E. Student Branches, held at Brown University, Providence, R. I., April 23 and 24, 1937, a new system of selecting the prize winners was used. This employs both faculty and student judges and, after a trial, it was agreed to use the same system this year.

Since the system used may be of interest to other groups, the rules to be used this year are given. They are as follows:

(1) Each branch will have its honorary chairman (or other faculty representative) and one student member act as judges. For Group I, this will mean 28 judges, each of whom will have the usual score sheet given him at the beginning of the session.

(2) Immediately after the last speaker has closed the discussion, the ballots of the judges will be taken without any discussion as to the relative merits of the speakers.

(3) For the first ballot, each judge votes for the 5 men who form the top of his list. Each judge distributes 15 points, relative to merit, among his 5 men with 5 points as the maximum for any one and 1 point as the minimum. Any judge, for example, might turn in his ballot with his 15 points distributed in one of the following ways:

5	5	5	5	5	4	4	4	3
5	5	4	3	3	4	4	4	3
2	3	3	3	3	4	3	3	3
2	1	2	2	3	2	3	2	3
1	1	1	2	1	1	1	2	3
—	—	—	—	—	—	—	—	—
15	15	15	15	15	15	15	15	15

(4) If the first ballot results in a clear-cut decision as to any position, so that two thirds of the judges feel that no further ballots should be taken for that position, the prize for that position is to be awarded according to the results of the first ballot.

(5) If any additional ballots are desired, the majority vote of the judges will decide what names are to be eliminated from the ballots. If they should decide to have only 3 names left on the ballot, each judge then distributes 9 points among these 3 men, with 5 points as the maximum for any one and 1 point as the minimum.

(6) The tellers will tabulate the vote on a

A.S.M.E. 1938 STUDENT MEETINGS

	Group	*Host Student Branch*	*Place*	*Dates*	*Committee Representatives*
I	New England*	University of New Hampshire	Durham, N. H.	May 6–7	A. C. Chick
II	Eastern	University of Pennsylvania	Philadelphia, Pa.	April 25–26	F. V. Larkin
III	Alleghanies*	University of Toronto	Toronto, Ont., Canada	May 2–3	F. V. Larkin
IV	Southern	Georgia School of Technology	Atlanta, Ga.	April 18–19	E. W. O'Brien
V	Mid West*	Marquette University	Milwaukee, Wis.	April 18–19	W. A. Hanley or H. O. Croft
VI	Northern Unit*	South Dakota State College	Omaha, Neb.	April 15–16	H. O. Croft
VI	Southern Unit	Texas A. & M. College	College Station, Texas	March 28–29	H. E. Degler
VII	Northwest Unit*	University of Washington	Seattle, Wash.	April 4–5	E. O. Eastwood
VII	Central Unit*	Colorado State College	Fort Collins, Colo.	April 11–12	R. O. Sink
VII	Southwest Unit	University of Southern California	Los Angeles, Cal.	. . . .	R. L. Daugherty

* President Harvey N. Davis will attend these meetings.

tally sheet, previously prepared by the host branch with a list of the speakers alphabetically arranged across the top of the sheet.

(7) At the time of registration at the conference, each judge, who has been selected by his branch, shall register on a special sheet provided for that purpose. This sheet will then show who is the faculty judge and who is the student judge from each branch.

(8) For a student to qualify to act as a judge from any branch, he must be a student member of that branch of the A.S.M.E. and also a junior, senior, or graduate student; and he must also be one who is not speaking in the competition.

(9) If any branch has no faculty representative or student (other than its speaker) present at the conference, that branch is not entitled to furnish any judge, unless the absence of both judges has been due to illness, accident, or road blockade, in which case the honorary chairman of the host branch may appoint two mechanical engineers to act for the absent judges. These substitute judges are not to be appointed unless the student speaker from this branch requests it.

(10) If any branch has only one qualified judge (either faculty or student) present, he may, if he so desires, select a mechanical engineer to act as an additional judge.

The foregoing rules have been formulated by the following committee selected for this purpose: Frank O. Ellenwood, chairman, Z. R. Bliss, Edwin A. Fessenden, Carl L. Svenson, and Roy V. Wright.

Briefly the committee selected the new scheme because they believe that:

(1) The students themselves should take an active part in the judging.

(2) The scheme of having only three judges has been unsatisfactory in many cases and often requires a long time to reach a decision because of the arguments involved with such a scheme.

(3) A public-speaking contest cannot be judged with exactness by any one, and a large number of judges are, therefore, much more likely to reach a just decision in such contests than are three.

(4) The time required to reach a decision is likely to be far less with a large number of judges, balloting without discussion as to the relative merits of the various speakers than it is with three judges who may have three different opinions and each one argues for his case.

At the interesting meeting held at Brown University last June, as soon as the judges were assembled after the technical session was finished and before any ballots were taken, it was evident that they believed that the present scheme of allotting 10 per cent for discussion is not a good one because oftentimes a good speaker with a well-prepared paper will arouse no discussion from the students. This may be due to lack of information on their part, so they do not know enough to ask any good questions; but it is more likely to be due to lack of time, because (*a*) discussion of the preceding paper may have been long, (*b*) it is time to go to lunch, or (*c*) it is near the end of the session and they are tired. Regardless of the cause, the 22 faculty and student judges at the Providence meeting felt that no speaker should be penalized because his paper was not discussed.

Since many people are interested in knowing how the student vote compares with that of the faculty, at this distinctive meeting ballots were given to the students as well as to the faculty. All ballots were collected and tabulated in an identical manner. These tabulations showed that the rating given to various speakers by the faculty judges was not materially different from that of the student judges. Differences of opinion were equally marked in both groups, and the experiment shows, to me at least, the desirability of having a large number of judges select the prize winners. In any contest of this kind, some difference of opinion is bound to exist among any group of judges regarding the relative standing of the contestants.

FRANK O. ELLENWOOD.[1]

[1] Professor, Heat Power Engineering, Cornell University, Ithaca, N. Y. Honorary Chairman, Cornell Student Branch.

Branch News

A.&M. Hears New Theory

A.&M. BRANCH of Texas had C. E. Sandstedt, member of the faculty, explain his new theory of the failure of elastic action. He had several samples of material to illustrate his talk and with the aid of graphs on the blackboard showed how the different forces of cohesion, stress, and strain were related. At another meeting, J. S. Hopper, also of the faculty, defined air conditioning and described many practical applications.

AKRON BRANCH had for its guest speaker, M. R. Bowerman, member, A.S.M.E., who gave an illustrated lecture entitled, "Requirements of Mechanical Engineering." A very lively discussion followed the talk.

ARIZONA BRANCH, the latest addition to our student branches, conducted an interesting meeting at which George E. A. Hallett, General Motors Corporation, related his experiences in the design and test of airplane and automotive engines.

Brooklyn Poly Learns About Ice Cream

The members of the BROOKLYN POLY BRANCH had Donald F. Ritterbusch, a student member, give a vivid description of the evolution of ice cream from an extremely rare table delicacy to its present widespread popularity.

Latest reports from BROOKLYN POLY (evening) tell of a trip to the Worthington Pump and Machinery Corporation at Harrison, N. J., and of a probable trip to Bethlehem, Pa., to visit the steel works.

BUCKNELL BRANCH heard that worth-while lecture on locks, as presented by Maxwell C. Maxwell.

California Tech to Meet Snow White

The boys at CALIFORNIA TECH BRANCH are planning an inspection trip to the Walt Disney studio in Hollywood where they expect to meet Snow White and the seven dwarfs, Mickey Mouse, Donald Duck, Pluto, and the rest of the famous characters created there. The most interesting technical feature will be the three-dimensional camera developed by Walt Disney's engineers.

CALIFORNIA BRANCH patterned its annual Spring Banquet after the dinner at the Annual Meeting of the Society by having Prof. R. W. Chaney, well-known paleontologist of the University, as the guest speaker. Other guests included Prof. M. P. O'Brien, who was toastmaster, and E. J. Sullivan, dean of SANTA CLARA and chairman of the A.S.M.E. San Francisco Section. Professor Chaney spoke on the migratory trend of plants and peoples in the western United States and Asia, and gave his personal views on the causes of the now raging Oriental conflict.

MEMBERS OF BROOKLYN POLY STUDENT BRANCH (EVENING) ON RECENT INSPECTION TRIP TO D.L.& W. LOCOMOTIVE AND CAR SHOPS AT KINGSLAND, N. J.
(This was the first trip of the Branch since its organization.)

Members of CASE BRANCH were given an illustrated lecture on rubber products by E. A. Theiss.

Catholic Univ. Members Meet Dr. Davis

Senior members of CATHOLIC UNIVERSITY BRANCH considered themselves fortunate in being invited to attend the luncheon meeting of the Washington Section where they had the

A BUNCH OF FUTURE MECHANICAL ENGINEERS, MEMBERS OF THE ACTIVE CASE INSTITUTE STUDENT BRANCH

pleasure of meeting Harvey N. Davis, president of the A.S.M.E. According to the report received from the branch, the students found Dr. Davis' talk stimulating, and the meeting most enjoyable.

COLORADO STATE BRANCH members listened to a lecture on precision instruments and fine measurements, given by Professor Pinsky, member of the faculty.

Cornell Shows Motion Pictures to 255

At a meeting attended by 55 members and 200 guests, CORNELL BRANCH had R. Beck, Bethlehem Steel Co., present two sound motion pictures, one on the construction of the Golden Gate Bridge, and the other on the manufacture of structural steel. The discussion which followed, proved to be the most interesting feature of the meeting.

An audience, consisting of members of JOHNS HOPKINS BRANCH and guests from the faculty and the A.I.E.E. Student Branch, greatly appreciated the showing of the Johns-Manville sound movie, "Heat and Its Control."

Idaho Runs Shop Picnic

A fine time was had by all who attended the shop picnic conducted by the IDAHO BRANCH on Jan. 18, 1938. The equipment in the laboratory and shop was demonstrated by the upperclassmen for the benefit of the underclassmen and others who had never been there before. Following this, ice cream and cookies were served to all who were present. The meeting was adjourned "after all the food was consumed."

The program for an evening meeting of IOWA STATE COLLEGE BRANCH consisted of two papers. The first was presented by R. S. Sherwood, graduate assistant in the M.E. department, and dealt with his experiences in the drilling and operation of oil wells. The second paper was given by Max Geise, student member, and concerned his experiences in drafting and jig production with the Maytag Washing Machine Co. A roll call was taken in the intermission between the two speeches.

Iowa State Discusses Employment

Following a custom of several years standing, a meeting of the IOWA STATE UNIVERSITY BRANCH was set aside for a discussion of employment problems confronting engineering students. Ralph M. Barnes, member, A.S.M.E., and professor in the college of engineering discussed the various problems and presented methods that have been found useful to students looking for work.

KANSAS BRANCH had H. L. Dixon, Ethyl Gasoline Corporation, who talked and showed a motion picture on "High-Compression Fuels for Motors."

A paper entitled, "Work of the Mechnical Engineer in a Chemical Plant" was given by Karl Doer, student member, at a meeting of the LEWIS BRANCH. Discussion followed his talk.

LOUISVILLE BRANCH heard two talks given by members. W. D. Wuest described the air-cleaning installation in the Field Building in Chicago, showing how dust is removed by electric precipitation, and R. W. Lovelace explained the workings of a machine gun.

600 Attend M.I.T. Meeting

M.I.T. BRANCH cooperated with the local chapter of the S.A.E. in exhibiting the General Motors Progress Exhibit which was attended by 70 A.S.M.E. student members and 530 visitors. The show consisted of various spectacular chemical and physical demonstrations, including several developed recently in the different fields of research. At the previous weekly meeting, H. S. FitzGibbon, president of the Pilot Packing Company, lectured on mechanical engine packings.

THE MICHIGAN TECH STUDENT BRANCH WON $10 WITH THIS SNOW STATUE OF A LINCOLN ZEPHYR AT ANNUAL WINTER CARNIVAL

At a meeting of the MARQUETTE BRANCH, a talk on dehydration by Mr. French of the Heil Manufacturing Co., was followed by a spirited discussion of the subject.

Besides the $10 won for the snow statue, a picture of which is shown, the MICHIGAN TECH BRANCH was awarded $5 at the winter-carnival parade for a float mounted on a 1908 White showing the advance made in the art of drilling.

Michigan State Praises Ogden

Donald McSorley, secretary of MICHIGAN STATE BRANCH, writes that much of the credit for the success of the branch meetings must go to Floyd Ogden, who is the publicity man and one of the busiest fellows in the organization. He prepares the meeting-notice posters, places them around the campus, puts meeting announcements in the school paper and, sometimes, in the local newspaper, and after the meeting is held, writes a description of it and sees that the item is published.

MICHIGAN BRANCH learned about the cold finishing of steel from F. J. Robbins, Bliss and Laughlin Steel Company, who illustrated his talk with motion pictures.

MISSISSIPPI STATE BRANCH had a member of the faculty, H. E. Graves, professor of chemical engineering, give a talk on the nitriting of steel.

At MONTANA STATE BRANCH, Tom Murdoch talked on the subject of high-speed Diesels and Peter J. Link told of his experiences in railroading.

NEBRASKA BRANCH had three student papers presented at one meeting. Keith Struthers explained the design and construction of the penstocks at Boulder Dam, Paul Doubt presented a treatise on graphical solutions, and Dean Leffler traced the development of the case-hardening process.

Junior Member Horner at Newark

E. A. Horner, junior member, A.S.M.E., spoke to the members of NEWARK BRANCH on the Society and its relation to the student member. Then, Donald Jones, who was graduated in 1936, covered the transition of the foundry from a manual art to the present-day machine-production process.

NORTH CAROLINA BRANCH has selected Fred Ullman to present a paper at the coming Student Meeting. Other members are assisting him in gathering material for his talk, which they hope will help him win first prize, thus bringing credit to them and their branch.

NORTH DAKOTA STATE COLLEGE BRANCH presented the motion picture, "The Story of Power" at one of its meetings.

NORTHEASTERN BRANCH members, back from their period in industry, were privileged to see an interesting film on the manufacture of wrought iron, shown by Mr. Gaffne of the A. M. Byer's Pipe Co.

Ohio State Plans Lounging Room

Having received a donation of money from the Student Senate, the OHIO STATE BRANCH is making arrangements to convert a locker room in the Robinson Laboratory into a lounging room for A.S.M.E. student members. Among the speakers during the last few weeks were

Dr. Davis, president of the A.S.M.E., who talked on "The Engineer of the Future," Professor Norman who gave a brief lecture on the movie showing the manufacture of wrought iron, and Professor Riley who spoke on "The Principles of Public Speaking."

OKLAHOMA BRANCH held a joint meeting with the student branch of the A.I.E.E. at which Philip S. Donnell, dean of the Engineering School, gave a paper entitled, "So You are Graduating!" It was a review of problems encountered by young engineers and of suggestions on solving them.

Penn State Meets With Engineers

PENN STATE BRANCH held a joint meeting with the Center County engineers' organization and the Central-Pennsylvania Section of the A.S.M.E., at which Maxwell C. Maxwell presented his talk entitled, "Loxology."

SOUTHERN METHODIST BRANCH held a joint meeting with the student branch of the A.I.E.E. to hear A. B. Pearson, chairman of the North Texas Section, A.S.M.E., and engineer with the Dallas Power and Light Co., give an illustrated paper on the Mountain Creek project of his company. The plant is designed to meet the future power requirements of Dallas.

At a meeting of the UNIVERSITY OF SOUTHERN CALIFORNIA BRANCH, Mr. Reichert pointed out the different ways of increasing automobile efficiency. One way is to increase the compression ratio by using blowers while another is to smooth out the passages into the combustion chambers. He cited a case of an engine of 230 cu in. displacement which was made to develop 200 hp with these methods.

High Finance at Texas Tech

In answer to our request for information about the branch's membership drive, Lester Mueller, corresponding secretary of TEXAS TECH BRANCH, reports that the membership was increased by 22 per cent as a result of the month's campaign. Gladwin Fairly brought in the most new members and thereby won the prize which covers his transportation expenses to and from the Student Meeting. To assure the payment of dues, each application had to be accompanied by a promissory note signed by the applicant.

TORONTO BRANCH held a joint meeting with the Junior Group of the Ontario Section at which H. G. Hill of the Juniors acted as chairman and V. M. Parrish, chairman of the Branch, introduced the student speakers. Discussing the subject, "The Junior Engineer in Industry," three Juniors and three students presented their views and experiences on the design, sales, and management phases. The student speakers were J. K. Ronson, H. L. Minaker, and J. A. N. Carmichael.

Students at Louisiana Convention

At the third annual convention of the Louisiana Engineering Society, a session was devoted to the presentation of papers by students from TULANE and LOUISIANA STATE UNIVERSITY. Donald E. Jahncke, TULANE, and J. R. Miller, L.S.U., presided jointly at the meeting. A. J. Ferguson, student member, L.S.U. STUDENT BRANCH, presented a paper entitled, "Mercury Steam Power Plants." Other papers were presented by members of student branches of the A.S.C.E. and A.I.E.E.

LEWIS INSTITUTE STUDENT BRANCH MEMBERS POSE FOR A PICTURE DURING A TRIP TO A DIESEL-ENGINE MANUFACTURING PLANT IN BELOIT, WIS.
(How do you like the profile of that fellow in the back.)

James M. Todd, vice-president, A.S.M.E., delivered a talk on the sulphur industry at a meeting of the TULANE BRANCH, illustrating it with motion pictures.

Utah Has Fuel Session

A fine meeting was had by the UTAH BRANCH. Dr. H. O. Cowles, member of the faculty, gave a paper on Utah coals, their classification and burning characteristics. W. L. Butler, engineer of Salt Lake City, discussed the local smoke problem, and emphasized the value of general education of the public in the control of combustion.

VIRGINIA BRANCH members turned out in force to welcome Dr. Harvey N. Davis on his recent visit there. After talking at a meeting of the branch, Doctor Davis had lunch with the faculty and with the officers of the Student Branch.

V.P.I. Sponsors Quiz Program

A novel program was presented at a meeting of the V.P.I. BRANCH. Patterned after the popular "Professor Quiz" program on the radio, engineering and technical questions were propounded and answered. Those participating in the program were R. S. Haws, W. W. Cox, H. R. Puckett, W. M. Walker, H. P. Hoggard, and R. G. Gibbs.

WASHINGTON BRANCH held a meeting at which several reels of motion pictures of wrought-iron manufacture and structural-steel rolling were shown.

YALE BRANCH continued its series of talks by faculty members by having R. R. Sears of the psychology department discuss the topic, "Influences Determining the Behavior of the Individual." At the weekly meetings held in January, papers were presented on various subjects by B. M. Shepard, R. Roseman, E. H. Scott, G. M. Neumunz, P. O'Gorman, R. T. Reeder, W. S. Kennedy, R. A. Lorenzini, and J. E. Murphy.

Some Student Branches Start Second Semester With New Officers

BELIEVING in the policy of giving as many members as possible the experience of running a student engineering society, some student branches started the new semester in February with a complete set of new officers, that is, chairman, vice-chairman, secretary, and treasurer. Out in ARIZONA, the cowboys, after a spirited campaign, elected Dick Lynn, Charles Nicholas, Robert Parsons, and William Knight. In New York, the members at C.C.N.Y. selected Herbert Steinmann, Philip A. Scheuble, S. Otis Sharpe, and Paul Pronsky.

KANSAS BRANCH reports that the choice of the members for the various offices were George Cobb, K. Willey, A. Johnson, and G. May. Traveling down MARYLAND way we meet Vernon H. Gray, Malcolm N. Collison, George E. Seeley, and Thomas N. Shaffer. Since MICHIGAN lost Chairman Edward L. Sinclair by graduation in January, Vice-Chairman Robert Young was unanimously elected to take his place, and Bob's place was filled by George Stuart. According to Corry McDonald, secretary of MONTANA STATE COLLEGE BRANCH, when it was found that the regular vice-chairman would not return to school, the members unanimously nominated and elected Richard Armond for the position.

NEBRASKA BRANCH elected Don Payne, Edmond Carlson, Ellis Smith, and Keith Struthers. At the very active NEWARK BRANCH, the members chose Frank Kreitler, Robert Frohboese, John Bermingham, and Ernest Csarzar. In Boston, the members returning to school from their period out in industry, selected John Bodnar, Martin E. Barzelay, and Robert B. Drinkwater, the latter for the joint office of secretary-treasurer. OHIO STATE has P. H. Curtiss, R. B. Hines, C. D. Lynn, and D. L. Getz. Out west where the oil wells grow, OKLAHOMA A.&M. BRANCH installed Stephen Spargo, Grant Turrill, Ernest Young (recording secretary), Lester Crider (corresponding secretary), and Paul Evans. The new secretary at UTAH is H. Dean Wilsted. The Society is proud of having such capable young men administer the affairs of their respective student branches and wishes them the best of luck.

Other Engineering Activities

Tool Engineers to Hold First Annual Meeting in Detroit

THE FIRST annual convention of the American Society of Tool Engineers will be held in Detroit, Mich., March 9–12, 1938. In connection with the meeting, the society is sponsoring the Machine and Tool Progress Exhibition at Convention Hall with more than 100 exhibits scheduled.

A.S.C.E. Elects Officers

AT THE eighty-fifth annual meeting of the American Society of Civil Engineers, held in New York, January 19–22, 1938, the following new officers for 1938 were inducted: president Henry Earle Riggs, vice-presidents Malcolm Pirnie and Edward N. Noyes, directors James A. Anderson, member, A.S.M.E., A. W. Harrington, Louis E. Ayres, W. W. DeBerard, Joseph E. Root, Ross K. Tiffany, and Thomas R. Agg.

N. E. Funk on Franklin Institute Committee

ON Dec. 15, 1937, Nevin E. Funk was appointed by President Harvey N. Davis to serve as the representative of The American Society of Mechanical Engineers on the Committee on Applied Science of The Franklin Institute in connection with the dedicatory exercises of the Franklin Institute Building, to be held May 19, 20, and 21, 1938.

N. Y. Safety Council to Hold Ninth Annual Convention

SEVEN THOUSAND delegates are expected to attend the ninth annual convention of the Greater New York Safety Council to be held at the Hotel Astor, April 19–21, 1938. This is one of the outstanding conferences of this type held anywhere in this country and, as in the past, many A.S.M.E. members will take an active part. The meetings will be open to any A.S.M.E. member who wishes to attend.

A.I.E.E. Nominates Officers

ACCORDING to an announcement dated January 27, 1938, the national nominating committee of the American Institute of Electrical Engineers, consisting of members from various parts of the country, has nominated the following official ticket of candidates for the offices becoming vacant August 1, 1938: For president: John C. Parker, member, A.S.M.E., vice-president, Consolidated Edison Company of New York, Inc.

For vice-presidents: Chester L. Dawes, F. Malcolm Farmer, member, A.S.M.E., A. H. Lovell, F. C. Bolton, and Lester R. Gamble.

For directors: Leland R. Mapes, Harold S. Osborne, and D. C. Prince.

For treasurer: W. I. Slichter, member, A.S.M.E.

These official candidates, together with any independent nominees that may be proposed later, will be voted upon by the membership at the coming election this spring.

Dean S. B. Earle Represents A.S.M.E. at Vanderbilt University Inaugural

APPOINTED Honorary Vice-President of the A.S.M.E. for the occasion, Dean Samuel B. Earle, of the school of engineering, Clemson College, represented the Society at the inauguration on Feb. 5, 1938, of Oliver C. Carmichael as Third Chancellor of Vanderbilt University, Nashville, Tenn.

In connection with the ceremonies, a symposium on higher education in the South, consisting of simultaneous sectional meetings covering medicine, law, engineering, and theology was held on the afternoon of Feb. 4, 1938. At the engineering meeting, presided over by Dean Earle, W. S. Rodman, dean of the School of engineering, University of Virginia, presented a survey of engineering education in the South, Ovid W. Eshbach, special assistant, American Telephone and Telegraph Company, discussed the trends in engineering education, and Harrison W. Craver, director of the Engineering Societies Library and president of the American Library Association, described the rôle of the library in engineering education and research.

Fifth Applied Mechanics Congress in Cambridge, Sept. 12–16, 1938

THE FIFTH International Congress for Applied Mechanics which meets at Harvard and at M.I.T. on September 12–16, 1938, will be distinguished by a general lecture on the strength properties of steel by Dr. F. Koerber, director of the well-known Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf, Germany. The American Organizing Committee has also invited general lectures from international authorities in other fields of applied mechanics whose names will be announced later.

J. F. Barkley Will Represent A.S.M.E. at Safety Meeting

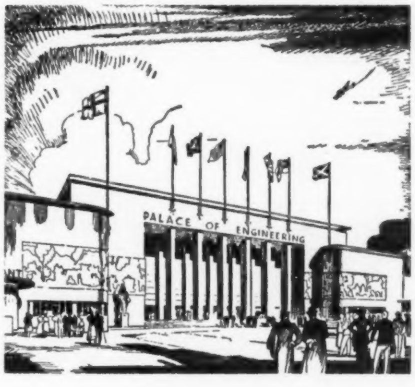
THE A.S.M.E. will be represented by J. F. Barkley at the annual council meeting of the Joseph A. Holmes Safety Association, to be held Mar. 5, 1938, in the conference room of the U. S. Bureau of Mines, Washington, D. C. The association is organized to promote safety efficiency in the mineral industries.

International Engineering Congress in Glasgow June 21–24, 1938

AN EMPIRE EXHIBITION, the largest since Wembley, will be open from May till October, 1938, in Bellahouston Park, Glasgow, Scotland. Since this exhibition is likely to be of considerable interest to engineers, the larger engineering societies in Great Britain have, therefore, cooperated to organize an International Engineering Congress to be held in Glasgow, June 21–24, 1938. This should enable engineers who participate in the Congress to visit the exhibition.

The American Society of Mechanical Engineers has accepted an invitation to send representatives and to contribute a paper to one of the sessions. Any member who intends to attend, is asked to communicate with the Secretary of the Society.

As befits an exhibition set in the heart of the most highly industrialized area in Great Britain, the largest building in this year's ex-



PALACE OF ENGINEERING

hibition is the palace of engineering which covers more than five acres. In line with modern ideas on architecture it is strictly functional and utilitarian, a building being judged today more on its suitability for the uses it has to fulfill and less on mere formal and unnecessary decoration. Nevertheless, its simplicity of line gives an impression of beauty of strength. The exhibits, from screw nails to giant castings, will illustrate the romance of iron and steel.

A.S.M.E. Members Institute of Physics Invited to Physics Institute Meeting

APPLICATIONS of the science of physics in the automotive industry will be the subject of a symposium to be held under the auspices of the American Institute of Physics at the University of Michigan, Ann Arbor, Mich., Mar. 14–15, 1938. An invitation to attend has

been extended by the Institute to all A.S.M.E. members who may be interested.

Subjects to be discussed will include the general relationship of physics to the automotive industry, scientific training, and a number of technical subjects, such as, seeing and lighting in connection with highway hazards, lubrication, noise measurement and other phases of automotive acoustics, physical methods of studying engine combustion, instruments, spectrochemical analysis, theory of materials, and others. The principal address scheduled for the dinner, Mar. 14, 1938, will be given by Charles F. Kettering, member, A.S.M.E., on the subject, "Scientific Training and Its Relation to Industrial Problems."

A list of other speakers includes Dr. Lyman J. Briggs, director of the National Bureau of Standards, K. T. Keller, member, A.S.M.E., president of the Chrysler Corporation, M. Muskat, Gulf Research and Development Corporation, J. S. Thomas, Chrysler School of Engineering, E. J. Martin, member, A.S.M.E., L. Withrow, and G. Rassweiler of the General Motors research laboratory, Paul Huber, General Motors Corp., and F. A. Firestone, department of physics of the University of Michigan.

2500 Expected to Attend Management Congress

Lord Leverhulme Received by A.S.M.E. and A.M.A.

PRESIDED over by Roy V. Wright, past-president of the A.S.M.E., a luncheon was tendered to the Right Honorable Viscount Leverhulme, president of the International Committee of Scientific Management, Jan. 26, 1938, on his visit to the United States on behalf of the Seventh International Management Congress, by the officers of the Society and the American Management Association. In responding to the welcome extended by Doctor Wright, Lord Leverhulme expressed his appreciation of the opportunity given him to meet those present at the luncheon and observed that about 2000 Americans, and from 300 to 500 from other countries, are expected to attend the Congress to be held in Washington, D. C., Sept. 19–23, 1938.

Others present at the luncheon were U. Baliol-Scott, secretary of the British Management Council and many members of the A.S.M.E., including L. P. Alford, past vice-president, William L. Batt, past-president, Harold B. Bergen, member and president, Institute of Management, Harold V. Coes, past vice-president, C. E. Davies, secretary, W. J. Donald, member and managing director, N.E.M.A., Harry A. Hopf, member and deputy president, International Committee of Scientific Management, and Robert T. Kent, member. Following the luncheon, Lord Leverhulme was taken on an inspection tour of the Engineering Societies Building, including the headquarters of the A.S.M.E.

The sponsoring group for the Congress is the International Committee of Scientific Management. This is a federation of national groups in Belgium, Brazil, Bulgaria, Czechoslovakia, France, Germany, Great Britain, Greece, Holland, Hungary, Italy, Yugoslavia, Poland, Rumania, Spain, Sweden, and the United States of America.

The American affiliate of the International Committee is the National Management Council, composed of The American Society of Mechanical Engineers, the American Management Association, the Association of Consulting Management Engineers, the International City Managers' Association, the Life Office Management Association, the National Office Management Association, the Personnel Research Federation, and the Society for the Advancement of Management.

Alfred P. Sloan Contributes $25,000 to Traffic Safety

A CONTRIBUTION of $25,000 to traffic safety by Alfred P. Sloan, chairman of the board of General Motors Corporation, was announced recently by the National Safety Council. The money is being given to the Automotive Safety Foundation by Mr. Sloan for additional and personal awards in the 1937 National Traffic Safety Contest conducted by the Council. The contest ended Dec. 31, 1937, and prize-winning cities and states will be announced early in April.

Twelve police officers and eight traffic engineers will be selected from the prize-winning cities and states in the Council's contest and sent to Northwestern and Harvard for a year's training in traffic safety. Each of these 20 policemen and engineers will be given $1000 in cash, plus the cost of a full year's tuition. Police officers will attend the Northwestern University Traffic Safety Institute and traffic engineers will go to the Harvard University Bureau for Street Traffic Research.

Mid-West Power Conference in Chicago, Apr. 13–15

ARRANGEMENTS are now being completed by seven mid-western state universities for the Mid-West Power Conference scheduled to be held at the LaSalle Hotel in Chicago, April 13–15, 1938. This conference will replace the original conferences previously organized under private and commercial sponsorship.

The program planned for the conference will involve about thirty papers presented by engineers and others from the educational and industrial fields. Among the various phases to be discussed are steam, Diesel, electric, and hydraulic power. Present-day practices as well as theory developed by research laboratories will be included.

Of peculiar interest will be a paper surveying the power requirements of the United States. Two papers presenting opposite sides of the controversial topic of valuation of power plants should create unusual interest. Equally controversial from the engineering viewpoint will be the discussion of Diesel versus steam power for driving modern railroad trains.

Anyone desiring to be placed on the mailing list in order to obtain full details about the conference should write to the director of the conference, L. E. Grinter, dean of the graduate division, Armour Institute of Technology, Chicago, Illinois.

A.S.M.E. to Be Represented at Political Science Meeting

HARVEY N. DAVIS, president of the A.S.M.E., has appointed R. A. Wentworth, Coleman Sellers, 3rd, and H. Birchard Taylor, as the official representatives of the Society at the forty-second annual meeting of The American Academy of Political and Social Science in Philadelphia, April 1 and 2, 1938. This year's meeting will be devoted to a discussion of the factors behind present international tensions and the relation of the United States to them.

Use of A.S.A. Standard in Ordering Pipe

AS an outcome of the formation some ten years ago of an American Standards Association Sectional Committee for standardizing dimensions and material specifications of pipe and tubing, Tentative American Standard B36.10 for Wrought-Iron and Wrought-Steel Pipe was published about two years ago. Following this probationary interval, the tentative standard is now being considered for advancement to full standard.

The aims of the committee in developing the standard were to (*a*) establish rational schedules of thickness based on ratios of pressure divided by stress, (*b*) include thicknesses suitable for welding, (*c*) provide suitable thicknesses in anticipation of development of new processes and materials for manufacturing and erecting piping, (*d*) eliminate unnecessary duplication by reducing the large number of intermediate weights of pipe to a few commercially practicable schedules of thickness, and (*e*) codify the various materials specifications suitable for manufacturing pipe and arrange formulation of additional specifications where required. Although the committee has produced a carefully considered standard in accordance with these aims, its commercial acceptance has not been as rapid as is desired.

Standard-Thickness Schedules Provide for Practically All Uses of Pipe

Rational schedules of thickness have been set up with reference to a constant ratio of fluid pressure to bursting stress throughout the entire size range to make feasible selection of wall thicknesses from the same schedule for all pipe diameters for any one pressure service, such as main steam piping, for instance. This is a decided simplification from former practice where selection from several weights of pipe was necessary if reasonably uniform working stresses were to be obtained throughout the range of diameters needed. Better conformance is assured between plant conditions and pipe-wall thickness as contained in the thickness schedules of the new standard than was the case formerly.

Lighter wall schedules than the old "standard weight" have been provided for economy in welded construction where the pipe is not weakened by threading. Rapidly increasing erection of pipe in the field by welding has enabled selection of thinner-wall pipe than was formerly available in "standard weight." More lighter-weight pipe would be specified now if it were available from jobber's stock. At present, these thicknesses cannot be secured from local jobbers, and Schedule 40 is often ordered when a lighter-weight pipe would serve to better advantage.

Selection of wall thicknesses in accordance with the standard has been confined largely to high-pressure high-temperature piping in central stations where the schedules have been found particularly helpful in providing standard thicknesses in alloy material. In an effort to avoid specifying of a large number of different wall thicknesses to suit individual pressure-temperature conditions, pipe manufacturers and the prime-movers committee of the Edison Electric Institute agreed to give preference to certain sizes and scheduled thicknesses of the new American Standard in ordering and stocking carbon-molybdenum pipe for central stations. Economic reasons for this standardization, to facilitate delivery, particularly on replacement orders, and to avoid a costly mill setup for producing a small quantity of pipe, will aid in the more wide-spread acceptance of this standard in the alloy field as the only means of avoiding a hopeless complexity of special wall thicknesses with attendant high production costs.

The primary purpose of the standard is to reduce the large number of odd weights of pipe to a few standard commercial schedules of thickness which will simplify the stocking problem to the extent that nearly any of the scheduled thicknesses can be secured from jobber's stocks. This aim has not been realized as yet because of unwillingness of the piping trade to abandon the obsolete terminology of "standard weight" and "extra strong" as such, although most of these thicknesses actually are included in the new Schedules 40 and 80.

Cost of Standard-Thickness Pipe to User Is Lower

The oil industry has been reluctant to adopt the B36 standard through fear that such action would curtail the possibility of obtaining odd thickness of pipe on special order from the mill. While this possibility is important where several miles of pipe are under consideration for a particular job as frequently is the case for cross-country gas and oil lines, the intention was not to urge too rigorous compliance with the standard, and manufacturers will no doubt, continue to make a special rolling where economical to do so. For small quantities of pipe as in refineries, however, accepting a standard thickness slightly over the minimum computed value, would seem to be more profitable in the long run, since lower cost of production with standard thickness schedules in effect will eventually be reflected in lower cost to the consumer. It is hoped that the oil industry will come to accept this viewpoint.

Lack of full cooperation between pipe manufacturers and consumers in adopting the new standard is penalizing both interests. In view of the obvious advantages to be derived by all, the tendency to order pipe for ordinary purposes in conformance with the schedule thicknesses should increase, thus ultimately effecting acceptance of the standard by the entire pipe trade. However, due regard should be given to the need for filling large mill orders with special-thickness pipe, if and when required.

All pipe producers should endeavor through their sales literature and contacts to fix the concepts of the new standard with their customers as the basis of purchase. At the same time, trade associations representing consumer interests can well give the matter publicity through their literature. Only through an active effort to acquaint the piping trade more fully with the aims of the standard can its use be extended to a point where real benefit will accrue. That its widespread adoption will be of distinct value cannot be questioned.

American Engineering Council

The News From Washington

Federal Housing Administration

HOUSING, in its several phases, is so much in the news from Washington, and it is getting such attention from the Administration that the Council feels obligated to keep member societies informed regarding major changes in the housing programs. The latest development has to do with construction of large housing projects as well as small residences, on which the Federal Housing Administration is prepared to guarantee the mortgages up to 80 per cent on larger undertakings and as much as 90 per cent on residences which do not cost more than $6000.

Engineers interested in the promotion of better housing for the public or in the design, construction, and maintenance of housing properties may, therefore, find helpful factual information in the excerpts from a summary of FHA releases to members of its own organization which have been made by the American Engineering Council. In fact, the officials of FHA feel that recent revisions in their laws make residential and apartment housing one of the more attractive forms of present-day investment and they insist that it is going to be good business for those contractors who may cater to it.

The Federal Housing Administration program under the amended law, signed by President Roosevelt on Thursday, February 3, 1938, is designed to assist families of moderate means to obtain adequate and decent housing on the most favorable terms in the history of the country.

In the language of the Senate Banking Currency Committee, it is intended "to utilize the best available means for achieving a sustained long-term residential construction program with a minimum expenditure of federal funds and a maximum reliance upon private business enterprise."

It deals solely with projects and mortgages that are considered economically sound. It is designed to be largely self-sustaining through the operation of a federal mortgage insurance system which has been carefully established and successfully operated since 1934.

The Housing Administration is authorized to insure a total of $2,000,000,000 outstanding at any one time and with the approval of the President this amount may be increased to $3,000,000,000.

"This program," said Administrator Stewart McDonald, "should prove a stimulus to the construction industry but too much should not be expected of it at once. The machinery is here for the government to do its part. The success of the program in the long run, however, depends upon the whole-hearted, voluntary cooperation of private capital and private industry, by which I mean the lending institutions, the material and equipment manufacturers and distributors, the builders and developers, and labor."

Public Works Administration

OFFICIALS report that the P.W.A. has no funds for either grants or loans and does not expect to have any unless Congress and the Administration should decide to appropriate more money for financing emergency construction for "pump priming" or "employment purposes." The P.W.A. insists that it is busily engaged in finishing all projects for which allotments have already been made and that it expects to go out of business. A large portion of the work is scheduled to be completed before June 30, 1938.

Since the Farm Security Administration, which is the new name for what is left of the Resettlement Administration, is almost entirely out of the construction business, the emergency construction of public works seems about to be left in the hands of the Works Progress Administration. The W.P.A. is said to be financing and directing a large volume of work in states of a public-works nature, but it is being subjected to much criticism and members of Congress who sponsor public works ideas are reported to be "feeling out" the President and their respective constituencies for encouragement to support legislation for more money for public works as an employment measure. In the meantime, it is

evident that many of those engineers and their associates who are handling public works and emergency construction must find other work within the next few months. Unless private industry and construction absorbs them, they are likely to present a real employment problem.

The heads of the several agencies are reluctant to serve advance notice because they feel that it would interfere with the work now in progress. Nevertheless, they see it coming and hope that private enterprise may be able to absorb all of those who must be separated from the service.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE

GRADUATE MECHANICAL ENGINEER; 17 years' manufacturing, cost control, and sales experience. Past 11 years and present connection, active staff of leading industrial-engineering concern. Close contacts with many varied industries. Me-12.

CHIEF ENGINEER seeks responsible position with manufacturer gas, gasoline, Diesel engines, compressors, other machinery. Many years technical and executive experience these fields. Particularly interested new developments. Inventive ability. M.E. degree. Me-13.

M. E. GRADUATE with 20 months' drafting experience, 11 months' experience in methods engineering work, and good technical knowledge of engineering principles, desires work in methods engineering or design. Me-14.

MECHANICAL ENGINEERING GRADUATE; Junior A.S.M.E.; I.R.E.; now employed; some experience and intensive training in radio. Desires new position in connection with electric control of machines or processes. Me-15.

MECHANICAL ENGINEER; Mem. A.S.M.E.; 33; 9 years' manufacturing experience including punch and die design, floor layout, purchasing, machine design, maintenance, supervision of mechanics, also dust-collector erection. Stevens graduate. Me-16.

RECENT GRADUATE, MECHANICAL ENGINEER, 27; 4 years' assistant to manager export-import concern handling machine tools and mechanical equipment. Sales and office experience. Salary not important if opportunity for advancement. Me-17.

MECHANICAL ENGINEER; 34; B.M.E., M.S., M.E.; 9 years' teaching laboratory and steam-power courses in mid-western university. Summer and part time spent in industry. Research and publications in hydraulics and refrigeration. Desires opportunity for advancement in teaching and research. Me-18.

MECHANICAL ENGINEER, Rensselaer graduate; age 39; 8 years' design and sales nonferrous heating surface; 4 years' combustion fuels steel plant and coke plant. Moderate salary with future prospects. Me-19.

MECHANICAL ENGINEER, 30 years' experience, desires position, manager or engineer, alkali manufacture. Capable taking complete charge design, erection, and operations. Also 3 years in charge building synthetic-nitrogen and acid plants. Me-20.

MECHANICAL ENGINEER; A.S.M.E.; A.S. R.E.; licensed N. Y. State; long experience negotiating and closing contracts for heavy machinery equipment, industrial plants, wishes position where personality, tact, and mature judgment count. Me-21.

GRADUATE MECHANICAL ENGINEER; 29; experienced in design, operation, and maintenance of chemical-plant and process equipment, desires position as member chemical plant engineering staff. Location immaterial. Me-22.

MECHANICAL ENGINEER; '36 graduate; single; age 25; 13 months hydroelectric plant operation; 4 months' steam-plant maintenance. Junior Mem. A.S.M.E. Excellent references. Desires experience in steam plant or oil field. Location immaterial. Me-23.

MECHANICAL ENGINEER; graduate Rensselaer Polytechnic Institute; 26; $3^1/_2$ years' engineer on design of pressure vessels, structural estimating, dust-control design, service, and steel erection. Location desired, western Pennsylvania. Me-24.

STEAM-TURBINE ENGINEER; 37; married; family; 6 years' heat calculations; 1 year sales; 8 years' design and development; desires responsible position with progressive concern. Me-25.

MECHANICAL ENGINEER; resourceful executive; wide experience in the design, development, and manufacturing of machinery, tools and products engineering. Me-26.

JUNIOR MECHANICAL ENGINEER; 25; Graduate Northwestern University, 1935; 2 years experience; planning production nonferrous metal-fabricating industry and general drafting work with same company. Will travel or locate anywhere in U. S. Me-27.

GRADUATE MECHANICAL ENGINEER, class '36; age 24; single; 15 months drafting experience, 4 months' shop experience; desires position as junior engineer, junior designer, or draftsman. Me-28.

MECHANICAL ENGINEERING GRADUATE; Junior A.S.M.E.; Mem. A.S.M.; $2^1/_2$ years' experience drafting, machine design, operation of machine tools, and heat-treatment of steel. Knowledge of ferrous metallurgy. Me-29.

GRADUATE MECHANICAL ENGINEER; age 28. Interested in production engineering—time study or research in either technical or personnel departments. Broad background of practical experience. Inventive ability. Excellent educational record. Me-30.

PLANT CONTROLLER, INDUSTRIAL ENGINEER. Graduate M.E., Rensselaer, 1929. Experienced supervision and management control of manufacturing, plant services, inventories, costs, with diversified processes. Adaptable, effective, responsible. Me-31.

DRAFTSMAN, young, with experience in industrial dust-collecting layouts, sheet-metal pattern drafting, and saleswork. Thoroughly familiar with the New York State labor department requirements and with shop practice. Me-32.

ENGINEER AND DRAFTSMAN experienced in patent matters, Mem. A.S.M.E., 10 years' conventional drafting-room experience prior registration patent office, seeks association with manufacturer to handle applications, drawings, or related work. Me-33.

GRADUATE MECHANICAL ENGINEER, young, experienced in automatic temperature control, heating, ventilating and air conditioning, and allied fields. Desires position either in sales or service. Location no object. Me-34.

CHIEF ENGINEER; 20 years' experience; for

(*Continued on page 282*)

A.S.M.E. Calendar

of Coming Meetings

March 23–25, 1938
National Spring Meeting
Los Angeles, Calif.

May 10–12, 1938
Machine Shop Practice Division Meeting
Rochester, N. Y.

June 15–18, 1938
Oil and Gas Power Division Meeting
Dallas, Texas

June 20–24, 1938
Semi-Annual Meeting
St. Louis, Mo.

September 5–6, 1938
Wood Industries Division Meeting
High Point, N. C.

September 12–16, 1938
Applied Mechanics and Hydraulic Divisions Cooperating in International Congress of Applied Mechanics
Cambridge, Mass.

October, 1938
Fuels Division Meeting jointly with A.I.M.E. Coal Division
Chicago, Ill.

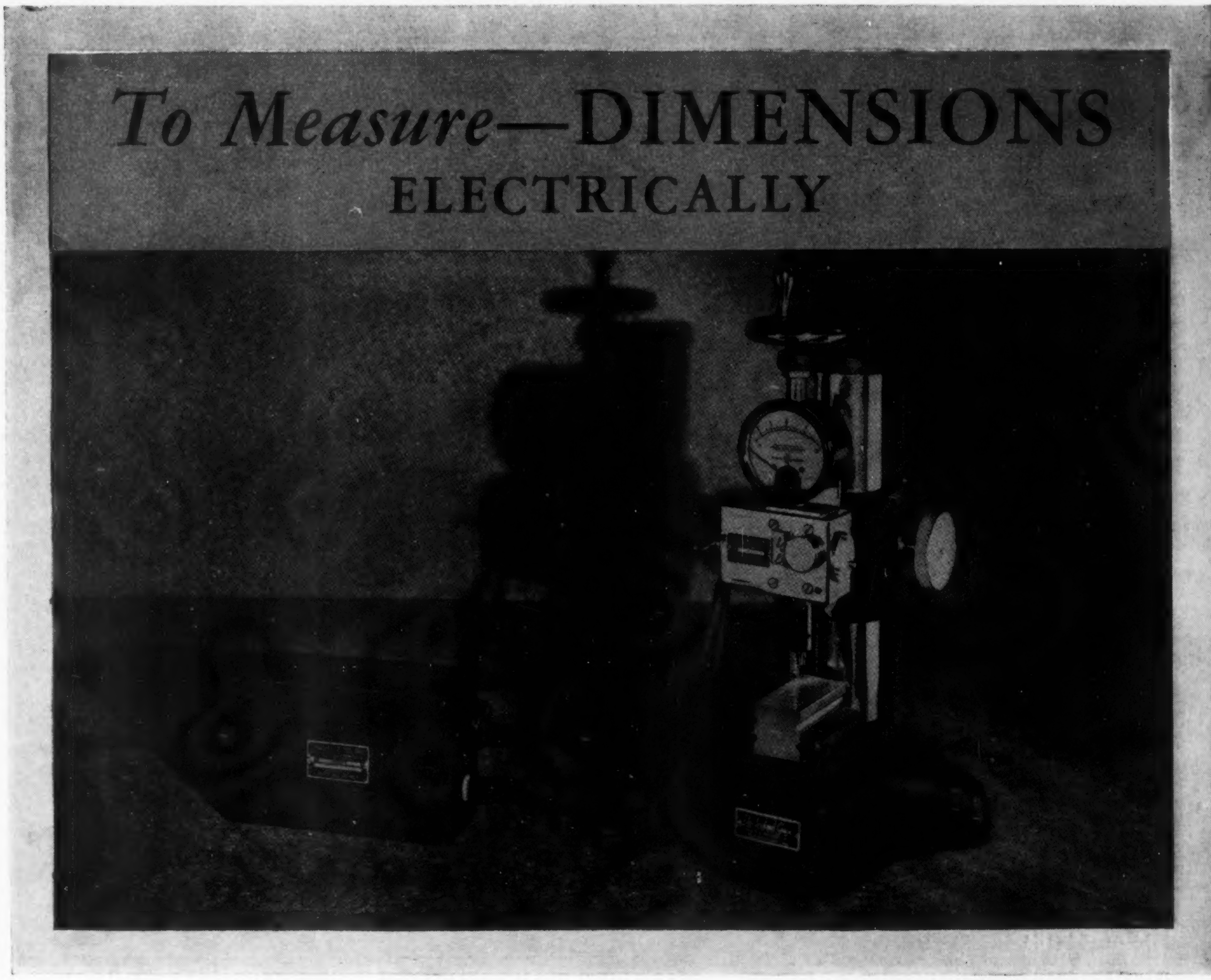


Photo courtesy Pratt & Whitney Co.

NOT the distance to the stars, but linear dimensions so minute that they are equally difficult to measure—such as 1/1,000,000 inch.

The electric gauge can measure them.

This simple, practical, highly accurate device, only recently developed by G-E instrument engineers, has already proved its worth. In the words of one user, "it has contributed more to the success of our product than any other single equipment."

In various forms, the electric gauge has found extensive use—for the inspection of finished parts . . . for the measurement of strain and of stress on bridges and in locomotives, and of pressure on the rolls of a steel mill . . . for the measurement of the thickness of enamel and plating on flat surfaces and of metal foil, and of many other materials.

Distance is but one of the many fields to which General Electric engineers have brought the science of accurate measurement. G-E instruments measure sound, light, vibration, color, and even the power of lightning. There are also instruments to measure current, voltage, resistance, watts, frequency, power-factor—in dozens of standard styles, indicating and recording, in ratings to fill every need.

For almost fifty years General Electric has been a leader in the design and manufacture of electric instruments. Its engineers have brought to measurement the experience gained in every field of electrical endeavor. If you have a problem that involves measurement of any quantity, remember General Electric, Schenectady, N. Y., as

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

GENERAL ELECTRIC

430-84

the last five years design and production, train salesman, sales promotion, organize and manage. Salary commensurate with results. Me-35.

POSITIONS OPEN

ASSISTANT PROFESSOR, graduate mechanical engineer, 30–35, to teach machine design and general mechanical laboratory work. Must have master's degree, and both practical and teaching experience. Salary, \$3000–\$3600 a year. Apply by letter. Location, New England. Y-2521.

PRODUCTION ENGINEER, graduate mechanical engineer throughly experienced in designing, tooling, and production of small, accurate mechanisms, produced largely over automatic screw machines and punch presses. Must be thoroughly experienced production planning and time and motion study as applied to variety of small, accurate parts. Only executive capable of organizing and operating production engineering department factory with several hundred employees will be considered. Must have wide experience in manufacture of complicated, accurate mechanisms, as calculating, adding, bookkeeping machines, cash registers, speedometers, etc. Apply by letter. Location, California. Y-2552CS.

MECHANICAL ENGINEER who has had responsible charge of manufacture of wire rods, tubes, and sheet-metal manufacture, preferably nonferrous. Must be thoroughly familiar with all mill practice, organization, and manufacturing procedure. Apply by letter. Location, New York, N. Y. Y-2638.

ADVERTISING MANAGER to head advertising and sales-promotion department of large, well-financed, internationally known manufacturer in electrical-appliance field. Must be able to coordinate activities of advertising and sales departments, handle budget, deal with both broad principles and details of whole promotional effort of the company and direct expenditures. Should have creative mind, and be able to work with higher executives of organization, own subordinates, and advertising agency. Opportunity. Apply by letter. Headquarters, New York, N. Y. Y-2662.

CHIEF ENGINEER, 30–45, mechanical or electrical, in welding field. Company does arc and acetylene and various types of welding. A practical man rather than a technical one is desired. Salary, \$5000 a year. Apply by letter. Location, Middle West. Y-2707C.

SHOP SUPERINTENDENT for company manufacturing boilers and special work. Must have experience in welding, riveting, shop practice, milling, boring, etc. Welding is essential. Apply by letter. Location, New York, N. Y. Y-2718.

CHIEF ENGINEER, mechanical, 38–45, to take charge of and direct engineering department of company manufacturing varied line of processing machines and appliances. Must be skillful development and design engineer. Man who has had charge of large jobbing shop would qualify. Apply by letter. Location, Middle West. Y-2730C.

Local Sections

Coming Meetings

Anthracite-Lehigh Valley: March 25. Lafayette College, Easton, Pa., at 8:00 p.m. Subject: "The Steel Industry in Lehigh Valley," historical narrative by several outstanding speakers.

Baltimore: March 18. Engineers Club of Baltimore at 8:15 p.m. Subject: "Design for Welded Structures," by C. E. Jennings, research engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Buffalo: March 15. The University Club, Buffalo, N. Y. Subject: "The Spectrograph," talk by member of Bausch & Lomb Optical Co.

Chicago: March 1. Meetings are held on thirty-sixth floor, Civic Opera Building, 20 North Wacker Drive, unless otherwise designated. (Junior Meeting) Subject: "Engineering Council for Professional Development," explanation of aims, activities, and accomplishments.

March 10. Bismarck Hotel at 6:00 p.m. Meeting sponsored by Sales Executive Club. Subject: "Sales and Management Analysis," by H. G. Weaver, sales research specialist, General Motors Corp., Detroit, Mich.

March 15. Power and Fuels Divisions meeting. Subject: "Fly-Ash Dust Collection," by W. S. Hudson, Buell Engineering Co., New York.

March 22. Manufacturing Division. Dinner meeting (time and place to be announced in Chicago Section's monthly bulletin). Subject: "The Mechanical Engineering in Patent Litigation," by Harry M. Huxley of the firm of Wilkinson, Huxley, Byron, & Knight.

March 29. Research Division Meeting. Subject: "Use of Glass as Fiber, Insulation, and Textile, by Games Slayter," director of research, Owens-Illinois Glass Co.

Cleveland: March 10. Guild Hall, 45 West Prospect Ave., Cleveland, Ohio, at 8:00 p.m. Subject: "Republic Steel 98 Strip Mill," by H. B. Carpenter, district manager.

Erie: March 8. Pennsylvania Telephone Corporation Auditorium. Joint Meeting with the American Society of Electrical Engineers. Subject: "From Flying Crates to the Modern Plane," by C. F. Green, designing engineer, aeronautics and marine engineering department, General Electric Co., Schenectady, N. Y.

New Haven: March 1. Strathcona Hall, New Haven, Conn. at 8:00 p.m. Subject: "Influence of Working Conditions on the Behavior of the Individual," by H. W. Haggard.

North Texas: March 9. Adolphus Hotel, Dallas, Texas at 7:00 p.m. (dinner meeting). The Ladies are cordially invited to this meeting. Subject: "The Engineer of the Future," by Harvey N. Davis, president of the A.S.M.E.

Norwich: March 18. Allyn Museum, New London, Conn., or Norwich. Subject: "High Lights of the International Yacht Races and some Engineering Considerations,"

(*Continued on page 284*)

Officers of A.S.M.E. Professional Divisions for 1938

AT ITS meeting on Jan. 10, 1938, the Executive Committee of the Council of The American Society of Mechanical Engineers confirmed the following list of officers for 1938 of the Society's professional divisions:

Division	*Chairman*	*Secretary*
Aeronautic	Alexander Klemin	Jerome Lederer
Applied Mechanics	C. R. Soderberg	R. Eksergian
Fuels	M. D. Engle	A. R. Mumford
Graphic Arts	B. D. Stevens	T. E. Dalton
Hydraulic	S. Logan Kerr	F. G. Switzer
Iron and Steel	S. M. Weckstein	Morris Stone
Machine Shop Practice	G. F. Nordenholt	J. R. Weaver
Management	L. C. Morrow	L. N. Rowley, Jr.
Materials Handling	R. B. Renner	F. J. Shepard, Jr.
Oil and Gas Power	E. J. Kates	M. J. Reed
Petroleum	W. H. Carson	J. H. Engelbrecht
Power	W. A. Carter	G. C. Eaton
Process Industries	Victor Wichum	T. R. Olive
Railroad	E. C. Schmidt	M. B. Richardson
Textile	H. D. Learnard	J. J. McElroy
Wood Industries	A. W. Keuffel	....

To serve as members of the executive committee of the newly organized Heat Transfer Group, the following were appointed:

J. H. Sengstaken, chairman, W. S. Patterson, secretary, Thomas Drew, E. D. Grimison, H. C. Hottel, C. E. Lucke, and A. K. Scott, members.

A NEW WORLD'S RECORD for STEAM PLANT EFFICIENCY

★ Port Washington again lowers the mark with a 1937 average of 10,835 Btu. ★

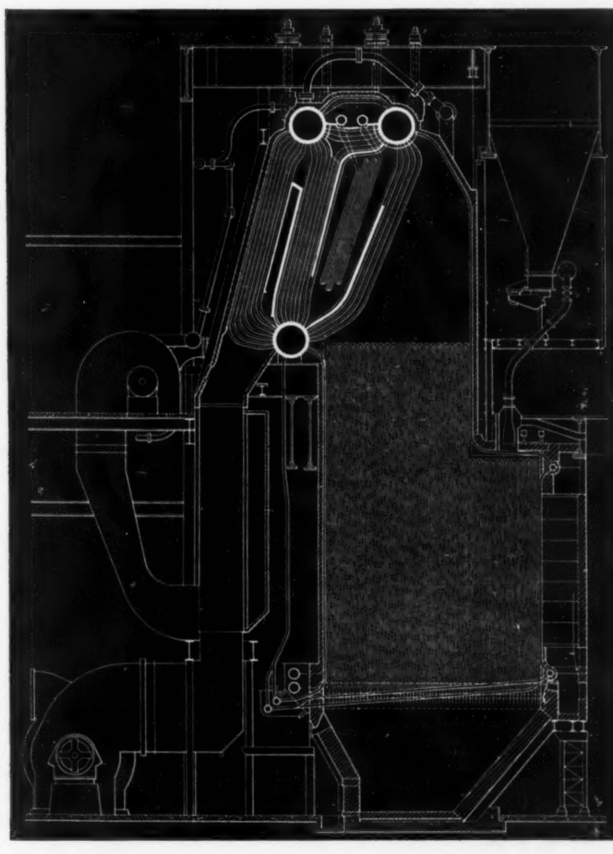
The Port Washington Station of The Milwaukee Electric Railway and Light Company, which comprises a single C-E Steam Generating Unit serving an 80,000 kw turbine-generator, went into regular operation in the latter part of 1935.

During 1936, its first full year of operation, this station showed an average heat consumption of 10,954 Btu per net kwh which marked it as the most efficient steam station in the world. The 1937 performance bettered this notable record, the average heat consumption having been reduced to 10,835 Btu per net kwh—a new world's record for steam plant efficiency.

For the entire period since the plant was placed in service to Dec. 26, 1937, it has been operated 86.2 per cent of the time. The distribution of plant outage is as follows: Scheduled Inspections—6.2 per cent, Lack of Load—2.5 per cent, Mechanical Trouble—2.2 per cent, Corrosion Trouble—2.9 per cent. The corrosion was determined to be of an electro-chemical nature and was eliminated in January 1937. The fact that Port Washington is not a base load station and that it is subject to a considerable load variation at times makes its record the more remarkable.

Combustion Engineering fully appreciates that a large portion of the credit for this performance record is attributable to the engineering ability and operating skill of those responsible for the station operation. We do feel, however, that here again we have convincing evidence that the confidence placed in the dependability and efficiency of C-E equipment, by those who have selected it for many of the most prominent steam generation projects of the last few years, has been amply justified.

Further recognition of the extra values obtainable in C-E equipment is found in the facts that C-E furnished the boilers last purchased for the world's largest public utility, industrial and central heating plants. Of the world's eight boilers having capacities of a million or more pounds of steam per hour, six are C-E Units.



C-E Steam Generating Unit installed at Port Washington Station. Designed to produce 690,000 lb of steam per hr at 1320 lb pressure and 830°F total temperature. C-E equipment includes Boiler, Front and Rear Water Walls, Air Heaters and Pulverized Fuel Burners, Mills and Feeders

Combustion Engineering Company, Inc.,
200 Madison Avenue New York, N. Y.
Canada
Combustion Engineering Corp. Ltd.—Montreal

C-E

A-398

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

by Zenas R. Bliss of Brown University, Providence, R. I.

Ontario: March 17. Royal York Hotel, Toronto, Ont., Can. Annual Ladies' Night. Movies by the Canadian Pacific Railway will be shown. Subject: "Loxology," by Maxwell C. Maxwell, assistant to the president, Yale & Towne Mfg. Co., New York, N. Y.

Philadelphia: March 22. Philadelphia Engineers' Club, 1317 Spruce St., Philadelphia, Pa. Subject: "Use of Alloy in Modern Cast Iron," by Messrs. R. G. McElwee, foundry engineer, Vanadium Corp., Detroit, Mich.; J. S. Vanick, development and research division, International Nickel Co., New York, N. Y.; T. J. Parker, metallurgical engineer, Molybdenum Corp., New York, N. Y.

Peoria: March 10. Pere Marquette Hotel, Peoria, Ill. at 7:15 p.m. All A.S.M.E. members in the Central Illinois territory are cordially invited to attend this meeting. Subject: "Aeronautical Transportation," by William Littlewood, vice-president, American Airlines, Inc., Chicago, Ill.

San Francisco: March 31. San Francisco Engineers Club at 7:20 p.m. Subject: "Petroleum, Its Geology, Production, and By-Products."

Syracuse: March 17. Technology Clubroom at 7:35 p.m. Subject: "Tool Steels," by Robert Warren, metallurgist, Crucible Steel Company of America.

Waterbury: March 2. Waterbury University Club Rooms. Subject: "Die Casting," by G. Chase, Scovill Mfg. Co.

Worcester: March 10. Sanford Riley Hall, Worcester Polytechnic Institute at 7:45 p.m. Subject: "Hydraulic Control of Machinery," by Waldo Guild, Heald Machine Co.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

BAKRADZE, JOHN, January 20, 1938
BRIGHTMAN, HOWARD L., May 10, 1937
BRIGMAN, BENNETT M., February 8, 1938
CAPP, JOHN A., January 6, 1938
FLINN, MELVILLE S., June 16, 1937
KELLER, EMIL E., January 7, 1938
KOCH, ROBERT A., August 29, 1937
MCKEE, WILLIS, December 4, 1937
METCALF, FRANK H., January 11, 1938
NORDBERG, C. VICTOR, June 3, 1937
PATCH, FRED R., January 20, 1938
PEASE, FRANCIS G., February 7, 1938
STONE, CHARLES W., February 3, 1938

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after March 25, 1938, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Rt = Reinstatement Re = Reelection
Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

ALLEN, ALAN R., Bloomfield, N. J.
ANDERTON, EARL F., Chester, Pa.
BELDEN, F. A., Weston, Mass.
BRIDGE, L. R., Port Arthur, Tex.
BROEZE, J. J., Delft, Holland
DABBS, QUINTON, University, Ala. (Re)
DANZ, HARRY O., Detroit Mich.
DAVEY, GERALD FREDK., Worcester, Mass.
DE VONEY, JOHN D., San Francisco, Calif.
DIVERALL, OSCAR W., Buffalo, N. Y.
DORNER, FREDERICK H., JR., Milwaukee, Wis.
EGGE, NEWPHER W., Upper Darby, Pa.
EISEMAN, FREDERICK F., JR., Chicago, Ill.
ENGBARTH, JOS. J., Los Angeles, Calif.
FAULL, CHAS. W., Santa Monica, Calif. (Re)
FISHER, C. DONALD, Allenwood, Pa.
FORD, J. H., Chicago, Ill.
GLEESON, MORTIMER J., Albany, N. Y.
GOEPFERT, FREDK. OTTO, Lyndhurst, N. J.
GOGAN, EDW. A., Cleveland, Ohio
GREENWOOD, CHAS. F., San Francisco, Calif.
HUTCHINS, ARTIE L., Albuquerque, New Mex.
JANICKI, J., Wilmette, Ill.
JEFFRIES, E. H., Toledo, Ohio
JOHNSON, JAS. STANLEY, Pasadena, Calif.
KEARNS, M. I., Scotch Plains, N. J.
KILPATRICK, A. VERN, Rolla, Mo.
LANGE, JOS. O., Chicago, Ill. (Rt)
LAPPLE, CHAS. E., Wilmington, Del.
LEGIER, EDW. W., New York, N. Y. (Rt)
LUNDBERG, HUGO B., JR., Mishawaka, Ind.
MARSHALL, PETER WATSON, Burlingame, Calif
MARTIN, E. A., Cleveland, Ohio
MCLAUGHLIN, EDMUND F., Harmon-on-Hudson, N. Y.
MILES, AARON J., Rolla, Mo.
MORAN, GEO. U., Detroit, Mich.
MORRISON, EDWIN V., JR., Brooklyn, N. Y. (Re)
NATIONS, EMMETT L., Hurley, New Mex.
OBERHAUSER, L. G., Saginaw, Mich.
PACANINS, ARNALDO, Venezuela, S. A.
PURDY, WM. F., JR., Flushing, L. I., N. Y.
REA, WM. E., Kansas City, Mo. (Rt & T)
REDDY, DERMOT, Cumberland, Md.
REEDY, FRANK, Houma, La. (Re)
RHEINGANS, W. J., Milwaukee, Wis.
ROSS, FRANK, St. Louis, Mo.
RUBIN, NORMAN, Brooklyn, N. Y.
SANFORD, CARL N., Chapel Hill, N. C. (Rt & T)
SCHLACK, BRUNO, Upper Darby, Pa. (Rt)
SCHULER, WM. M., New York, N. Y.
SCOTT, ARTHUR L., Toronto, Ont., Can.
SIMS, E. M., Norman, Okla. (Re)
SPEICH, C. J., South Norfolk, Va.
STEWARD, D. P., Johnstown, Pa.
STOLPER, WALTER H., Los Angeles, Calif.
THORNTON, W. LLOYD, Peoria, Ill.
TILL, RALPH J., Swarthmore, Pa.
TOLMAN, CHAS. P., Kew Gardens, N. Y (Rt)
TRIGGER, KENNETH J., Bethlehem, Pa. (Re)
TUCKER, DAVID A., Lansdowne, Pa. (Rt & T)
VOLLBRECHT, J. T., St. Louis, Mo.
VISNICK, ALEX., Brooklyn, N. Y.

APPLICATIONS FOR CHANGE OF GRADING

Transfers to Fellow

CLARKE, C. W. E., Philadelphia, Pa.
WHITNEY, H. LEROY, New York, N. Y.

Transfers to Member

CALDER, A. W., JR., Providence, R. I.
DAVIS, CHAS. A., JR., Peoria, Ill.
DONOVAN, EDW. L., Yonkers, N. Y.
FLEMING, BURRITT G., Cincinnati, Ohio
HARMON, GEO. A., Newark, N. J.
KEENER, H. JAMES, Jackson Heights, N. Y.
MOYER, ROBERT E., JR., Allentown, Pa.
PLACE, OLIVER, Aurora, Ill.
SMITH, ERIC H., Worcester, Mass.
SOGARD, RALPH H., Columbia, Mo.

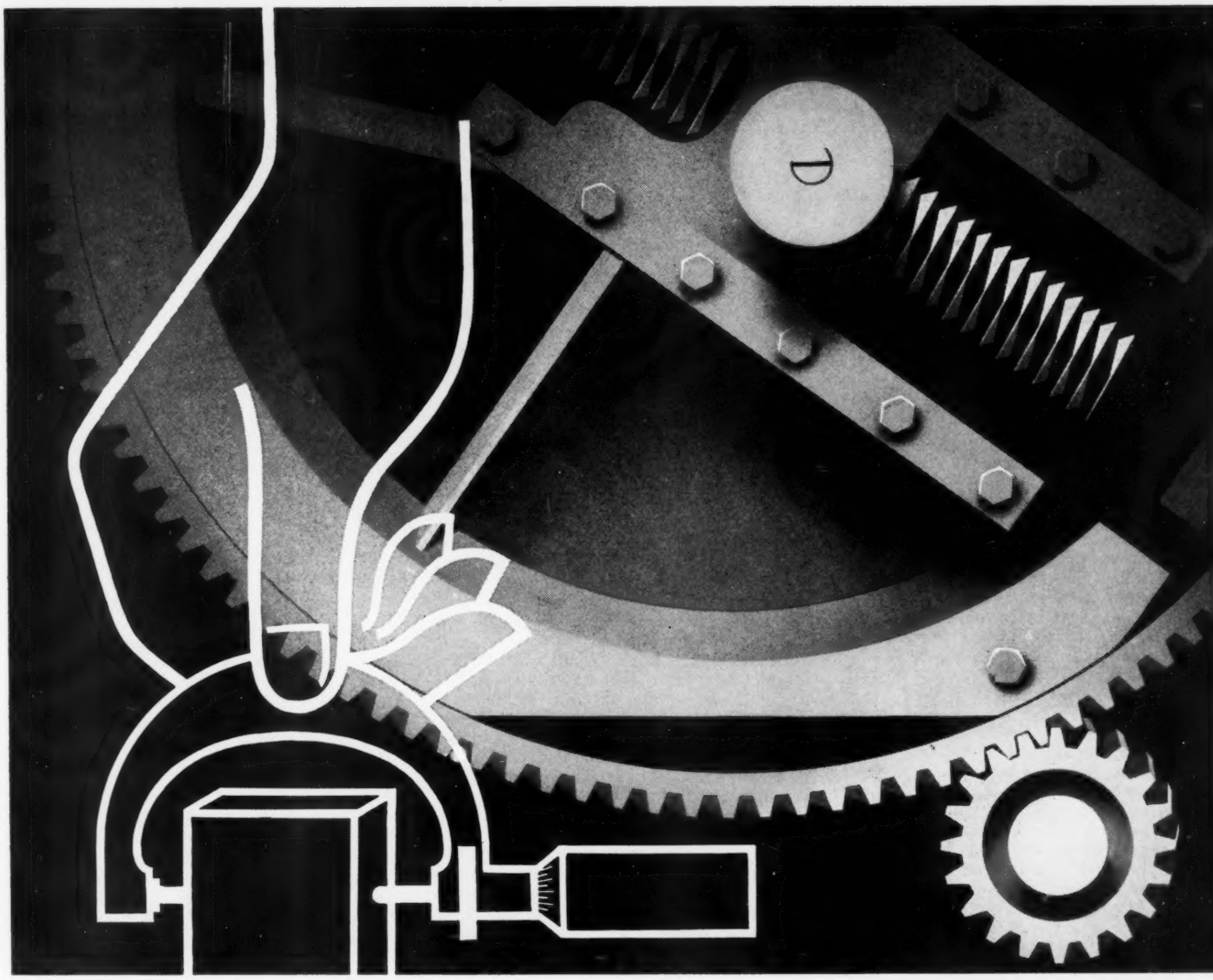
A.S.M.E. Transactions for February, 1938

THE February, 1938, issue of the Transactions of the A.S.M.E., contains the following papers:

An Experimental Investigation of the Use of Oil for the Treatment of Coal (FSP-60-6), by R. A. Sherman and J. M. Pilcher
The Hydraulic Jump in Sloped Channels (HYD-60-1), by B. A. Bakhmeteff and A. E. Matzke
The Problem of Flywheel Effect and Speed Regulation for Diesel-Engine-Driven Machinery (OGP-60-1), by A. D. Andriola
Determination of the Rate of Discharge in Jerk-Pump Fuel-Injection Systems (OGP-60-2), by K. J. DeJuhasz
U. S. Navy Correlation of Laboratory Tests on Diesel Fuels With Service-Engine Operation (OGP-60-3), by W. F. Joachim
Lubricating Problems in Connection With High-Speed Diesel Engines (OGP-60-4), by C. G. A. Rosen
The Design of Railway Axles and Locomotive Crankpins (RR-60-1), by R. Eksergian

DISCUSSION

On previously published papers by Messrs. R. E. Dillon, G. C. Eaton, and H. Peters; J. I. Yellott and C. K. Holland; C. F. Hirshfeld and E. H. Piron; W. C. Rudd and B. J. Mullen; and A. I. Totten



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Announcements from advertisers in MECHANICAL ENGINEERING and the MECHANICAL CATALOG

• NEW EQUIPMENT

New Oil-Proof Pushbutton Stations for Machine-Tool Service

General Electric Co., Schenectady, N. Y., Industrial Department, has recently announced a new line of low-priced, compact, standard-duty push-button stations specifically designed to resist the deteriorating action of oil and dirt encountered in machine-tool applications. These small stations are provided with a graphited packing ring between the button proper and the bushing, or oil guard. This packing ring prevents the seepage of oil or grease from operators' gloves or hands into the button mechanism.

To meet the varied requirements of the machine-tool industry, the line includes flush-mounted, surface-mounted, momentary-contact, and selector switch units.

Adjustable Pitch Diameter Sheaves

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has just announced a new series of two groove adjustable pitch diameter, texsteel sheaves for a speed variation up to 33% on any driven unit. This type of sheave provides a sturdy, inexpensive, easily adjusted, variable speed drive for applications where the required load does not exceed 3 horse power. They are now available in three sizes of 2" to 3", 2.5" to 3.5" and 3.5" to 4" variations respectively.

The pitch diameters on these sheaves are easily changed in a moment, by stopping the motor, relieving the belt tension, releasing the Allen head locking screw and turning the adjustable plate in or out to the desired pitch diameter. These sheaves are furnished complete with a wrench for the Allen head locking screw and a circular calculator showing directly the speeds of the driven unit.

These sheaves have been newly designed and carry many improvements in construction. The stationary part of the hub is cast integrally around the steel plates so that no amount of hard usage or abuse can loosen them. The movable portion of the hub is similarly constructed with sufficient material to form an external brace on the outside plate, thus assuring a smooth, true-running sheave at all times.

This company has also added an intermediate diameter texsteel sheave to its single groove adjustable pitch diameter series. These also have a speed variation of 33 per cent for ratings up to $1^{1}/_{2}$ horse power.

New Line of Goulds Pumps

Goulds Pumps, Inc., Seneca Falls, N. Y., announces for 1938 a complete new line of single stage, side suction, ball bearing Centrifugal Pumps. There are eighteen sizes with capacities from 5 to 1800 GPM against heads up to 110 ft. for flat or V Belt or direct motor drive. The most modern hydraulic design is embodied in casings, impellers, and stuffing boxes. Structural strength and amply proportioned parts are there without excess weight. High quality materials, ingenious design and fine workmanship insure outstanding performance, trouble-free service and long life—all at surprisingly low prices, possible only through mass production by Goulds modern methods. New Goulds Bulletin No. 210 gives complete details, data tables and all needed information.

Farrel Hydraulic Molding Press

The press shown in the accompanying illustration was built by Farrel-Birmingham Company, Inc., Main and State Streets, Ansonia, Conn., for the molding of automotive brake blocks. The press is the self-contained, individually-powered type, with the motor-driven pump mounted on top of the press. The press has a maximum capacity of 500 tons with one down-acting 21" diameter ram and two $6^{1}/_{8}$" double-acting cylinders mounted in the top crosshead and working under an initial pressure of 2600 lbs. per square inch.

The press has a maximum opening of 24" and a maximum stroke of 24". The platen area is 38" × 31". Both the bottom and moving crossheads are provided with tee slots for the attachment of molds. Adjustment of the moving crosshead guides is made possible by adjustable bronze gibs sliding against the finished interior surfaces of the press side frames.

The power unit is a 23.8 gallon-per-minute radial piston pump mounted, with the oil tank, on the top crosshead.

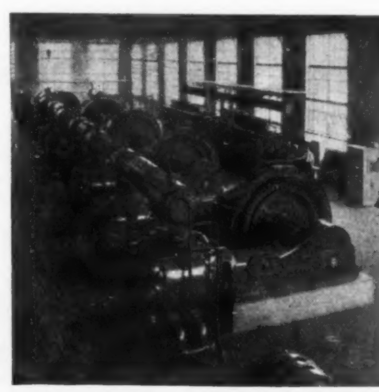
The control panel provides for pressure regulation over a range of from 10 to 500 tons. By means of a selective pressure system, this range of pressures has an infinite variation from minimum to maximum. Any ten pressures in this range may be set for immediate selection. On the "low" selection of pressures, the $6^{1}/_{8}$" diameter double-acting rams are used alone, and develop a minimum pressure of 10 tons to a maximum of 75 tons. Above the 75 ton range, press pressures are developed by both the $6^{1}/_{8}$" rams and the 21" main ram, and can vary by small increments up to the maximum of 500 tons.

The dwell of the selected pressure on the work may be automatically timed over a range of from 2 to 40 seconds by an automatic timing device.

A working cycle of the press is effected by push button control, movement of which causes the moving crosshead to descend, engage the work at the predetermined pressure for the predetermined period of time, and upon completion of this "dwell" return to the top position.

Electric Driven Direct-Connected Compressors

The developments and refinements accomplished in over thirty years of manufacturing direct-connected synchronous-motor-driven compressors, are presented in a new 56-page catalog covering class "PRE" compressors, recently issued by the Ingersoll-Rand Company.



These machines, built in sizes from 200 to 3000 HP, utilize the constant-speed synchronous motor which is efficient at compressor speeds, and not only is valuable in correcting a lagging power factor produced by other motors of the induction type, but, because of a large air gap, requires practically no bearing adjustment. These compressors embody the automatic Five-Step Clearance control method of regulation which cushions the inertia forces of reciprocating parts, thus materially reducing bearing loads and power-line disturbances. The "PRE" is equipped with the I-R channel valve, the characteristic of which is sustained and silent operation at high efficiency.

The new catalog itself embodies several unique features, notable among them being a two-page chart devoted to the interrelation of the design of the compressor and its

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operation in service. More than fifty representative installations in all parts of the world occupy twenty pages of the catalog No. 3426, copies of which may be obtained from Ingersoll-Rand, 11 Broadway, New York, N. Y., or any of their branch offices.

New Link-Belt Crusher

A new Two-Roll Spring-Relief Coal Crusher, known as Chain Drive Type "C," has been developed and placed on the market by Link-Belt Company, Chicago, Ill. The standard sizes include crushers with rolls of 26", 30" and 36" diameter. Among the desirable features noted are: 1, simple, compact design, saving space; 2, unbreakable all-welded steel framework, combining lightness with strength; 3, ease of adjustment for any size of product, within the crusher range; 4, smooth, quiet operation; 5, low maintenance cost. The large capacity with limited degradation, inherent in two-roll crushers, and the ease of adjustability for regulating the size of product, always claimed for single-roll crushers, are said to be combined in one sturdy, well-constructed compact unit.

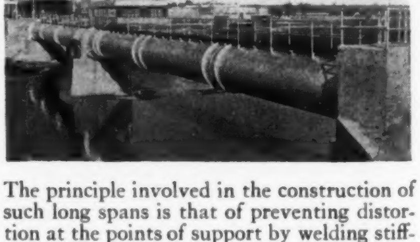
A major feature of the design is the use of cut tooth wheels and Silverlink roller chain for forming the driving connection to both rolls, from the crusher countershaft, which is mounted in anti-friction bearings. The roll shafts are carried in heavy rigid bearings, with one shaft adjustable to vary the size of product or to compensate for wear. Adjusting sleeves are provided with relief springs as a protection against excessive stresses, and any shock from these springs is transmitted directly to the welded frame. The rolls are of the segmental type, having cast iron spiders to which are bolted heavy alloy iron segments, heat treated to a Brinell hardness of from 500 to 600. Segments can be readily removed without removing the side housing.

Tests and actual service have shown that more accurate sizing of the product is possible than with the usual two-roll crusher; and smaller fly wheels and higher speed motors can be employed. Compared with the older-type of two-roll adjustable crusher with 36" diam. rolls, and with long-tooth gears for connecting the two rolls, as much as 3'–3" has been saved in head room on the new 36" size. Comparison with another 36" machine (having 48" long rolls) showed a saving of 1'–8" in width and 6'–4" in length.

New catalog No. 1654, covering all sizes, will be sent upon request addressed to Link-Belt Company, 300 W. Pershing Road, Chicago, or other office of the company.

World's Longest Horizontal Self-Supporting Pipe Span

Until the two spans of pipe shown in the accompanying illustration were constructed, a pipe span of a hundred feet was unheard of. The spans illustrated here are each 105 feet long. The structure carries sewage across the Platte River to the new sewage disposal works at Denver, Colorado. This is to be the longest unsupported span of pipe in the world. It was made possible by new theories in the design of supporting metal pipe which have led to use of a new method of construction.



The principle involved in the construction of such long spans is that of preventing distortion at the points of support by welding stiffener rings to the pipe. These rings transmit the load to the foundation by means of legs attached to them. Use of the new method of construction demonstrated a saving in cost of 22% over the next most economical design, and offered less obstruction to flow inside the pipe. The welding was done by the shielded arc process with equipment manufactured by The Lincoln Electric Company, Cleveland, Ohio.

The pipe is 78 inches in diameter, and ranges in thickness from $^5/_8$ inch to $1^1/_8$ inches. The stiffener ring at the center pier is a 12-inch per 40 lb. I beam rolled edgewise. The legs on this ring are rigidly fastened to the center pier. The stiffener rings at the ends of the pipe are 10-inch per 30 lb. I beams. The legs on these rings rest on patented rollers. An expansion joint in the wall at each end of the pipe allows it to expand both ways from the center. All seams were butt welded electrically.

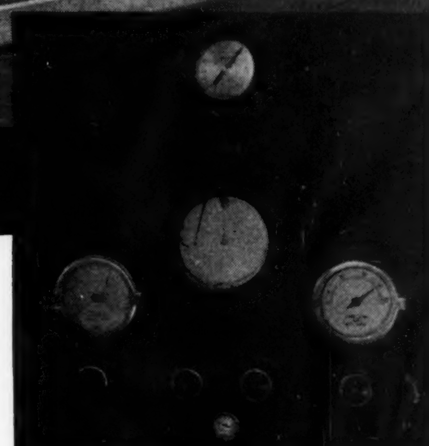
The pipe was designed as a continuous structure for a maximum combined fibre stress of 9,800 lbs. per sq. in. in the pipe shell, and 16,000 lbs. per sq. in. in the stiffener rings. Maximum negative bending moment at the

Continued on Page 20

Utmost FLEXIBILITY

Allis-Chalmers Blast Furnace Turbo-blower; 40000 cfm at 30 lbs G, 3630 rpm, turbine driven, at Hamilton Coke & Iron Company.

Control panel, with volume indicating and recording dials, volume setting dial and dial for barometer and temperature corrections.



● **This blast furnace blower installation represents the utmost in flexibility and ease of control. The turbine speed is automatically varied to keep the desired constant weight of oxygen delivered to the furnace, regardless of changes in barometric pressure, temperature, furnace resistance or steam conditions. The control can be instantly shifted to manual control in emergencies, and in addition, the blower is equipped with hand-operated movable diffusers, enabling the volume to be reduced as low as 20% of rated volume at full pressure, without surging.**

- **Blower**—4 stage, uncooled, Brown Boveri type.
- **Turbine**—4600 hp, reaction type, straight condensing.
- **Base**—Continuous welded steel.
- **Control**—Askania automatic constant oxygen weight. Movable diffusers on blowers.
- **Safety Features**—Emergency overspeed governor, pre-emergency governor, no exposed moving parts.

860

BLOWER AND COMPRESSOR DIVISION

ALLIS-CHALMERS

MILWAUKEE · WISCONSIN

center pier is 4,138,000 pounds feet. It occurs at points 39 feet 4 inches from the end supports.

The pipe was designed, fabricated or copper molybdenum iron by electric welding and erected by the Thompson Manufacturing Company of Denver, Colorado.

Old Generator Taken Out of Service After 47 Years

The modernization program of the Indianapolis Railways has made a relic out of one of the most interesting pieces of electrical equipment in Indianapolis—the first generator used to furnish electric power for street cars in that city. Installed in 1890, the generator was built by the Thomson-Houston Company, a forerunner of the General Electric Company. It was in use almost constantly since that date until a few weeks ago when the Railways' new shop was completed.

In 1900 the generator was moved from its original building and placed in the West Washington Street car barns, where it was in use ever since as a motor.

Even after 47 years of service the machine is still in running condition. It was moved because the building in which it was located had to be razed to make way for the new transportation building of the Indianapolis Railways.

• BUSINESS CHANGES

Allis-Chalmers Organization Changes

Allis-Chalmers Manufacturing Company's (Milwaukee, Wis.) Publicity Department for power, electrical and industrial machinery now has two sections, effective since January 15th.

George Callos has been appointed Assistant Manager in charge of sales promotion embracing advertising, bulletins, exhibitions, house organs, etc.

A. K. Birch has been appointed Assistant Manager in charge of market analysis, sales organization service embracing price books, data and sales information, and the distribution of literature.

Fairbanks-Morse Moves General Offices

Early in January, Fairbanks, Morse & Co. moved its general offices to the modernized Fairbanks-Morse building at 600 S. Michigan Ave., Chicago. This is but four blocks from the building at 900 S. Wabash Ave., which was the company's headquarters for a third of its 108 years. And it is only eight blocks from the site of the Fairbanks-Morse store on State St. near Madison St. that was destroyed by the Chicago Fire in 1871.

The company's new quarters have been completely remodeled and redecorated. New facades on both its Michigan Ave. and Harrison St. sides give the building a modern appearance in keeping with its interior treatment. A new elevator system, attractive wood paneled elevator corridors, glass-blocks office partitions and other improvements combine practicality with attractiveness to provide ideal offices.

The first five floors of the building are occupied by the executive, sales and departmental offices. In the display room on the first floor are shown some of the company's various products. Grouped about a ten-ton, eight-cylinder Diesel engine are electrical machinery, pumps, scales, railroad and farm equipment, household appliances, automatic coal burners and air conditioners—products that are manufactured in Fairbanks-Morse factories throughout the country and sold all over the world.

Timken Engineers Advanced

Following the resignation of Ernest Wooler, Chief Engineer of The Timken Roller Bearing Company, Canton, Ohio, A. L. Bergstrom has been appointed Executive Engineer to coordinate some of the varied engineering activities of the company. A graduate of the Royal Technical Institute of Sweden, Mr. Bergstrom spent several years with the Krupp organization in Germany. After a number of years in design work in this country, he became connected with The Timken Roller Bearing Company in 1929 in the Works Engineering Department, advancing to the position of Chief Works Engineer, which position he filled until his appointment as Executive Engineer of the company.

With Mr. Bergstrom's appointment, the company also announced the following promotions in the several divisions: R. M. Riblet to be Chief Engineer of the Automotive Division, J. B. Baker to be Asst. Chief Engineer of the Automotive Division and Chief Engineer of the Rock Bit Division. S. M. Weckstein is appointed Chief Engineer of the Industrial Division, H. C. Edwards will be chief Engineer of the Fuel Injection Equipment Division, W. C. Makley will be Chief Works Engineer, and E. J. Reagan, General Service Manager.

Name Change to Thomas Foundries

The Thomas Grate Bar Company 4200—10th Ave., N., Birmingham, Alabama, was organized in the fall of 1910, to produce and market a line of high grade grate bars of special design patented by the late Edward L. Thomas, who organized the firm. The business grew and before Mr. Thomas' death in 1923, Thomas Grates had gained widespread usage in practically every section of the United States. The success of the company is attributed to the fact that the basic design of its original product was good, because other types of grates to handle the special conditions arising in industry from time to time were added, and because only the highest grade materials were used in the production of a high grade product, no compromise with quality ever having been made in order to meet the competition of lower grade products.

In recent years, and more especially for the past year or two, the company has devoted considerable effort to the production of various types of gray iron castings with particular emphasis on special compositions of iron for service under severe conditions in industry, such as high temperatures, corrosion and abrasion, and service involving the use of cast irons of high strength. The use of alloys such as Nickel and Chromium, as well as others, plays a large part in the production of such materials.

Now, after more than a quarter of a century the company is changing its corporate name to Thomas Foundries, Incorporated. This change is being made in order to more effectively serve industry with specialized grades of alloyed and plain gray iron of various and sundry purposes, but needless to say while enlarging its market and field of operation with a new name and new product, the production of Thomas Grates will continue as in the past. The new company will be operated by the same management with no changes in personnel except for additions to its organization as are necessary for the production of high grade cast iron products, in keeping with the remarkable progress made during recent years in the new science of producing and controlling this material to specified compositions. The officers

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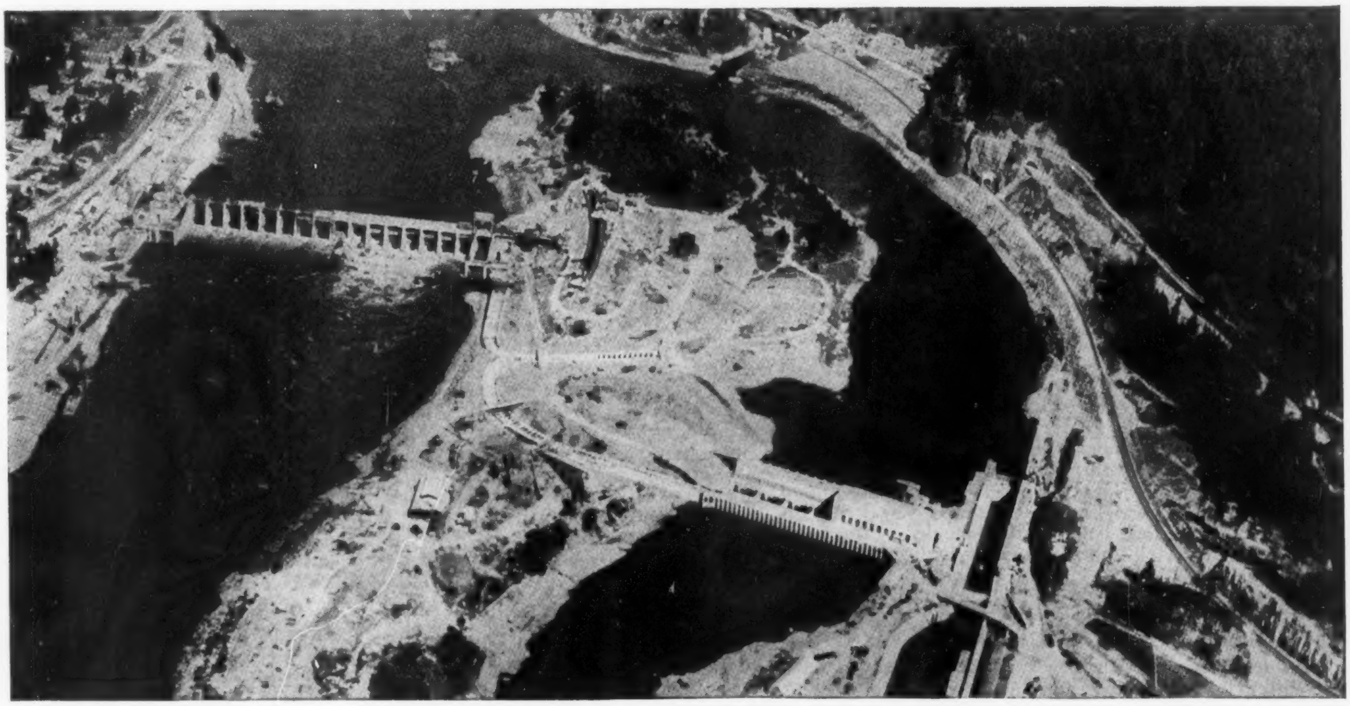
Bonneville Dam gives

TOUGH JOBS

to more than 800 SKF Bearings



SKF

BALL AND ROLLER BEARINGS

ONCE MORE SKF Bearings play an outstanding part in the development of a great dam. On Boulder Dam and other big projects, they established new records for always-on-the-job performance.

When Bonneville Dam was in its infancy, SKF Bearings helped shovels, mixers, trucks, pumps, draglines, compressors, motors and other machines move fast and efficiently. Later, 66 SKF's were assigned to two Morgan 350-ton gantry cranes. Today, more than 800 of them are taking loads up to 210,000 pounds on spillway and power house gates . . . on Bingham pumps throughout the entire dewatering system . . . and on a variety of other locations.

On job after job with SKF Bearings, many advantages stand out. The greatest of them all is their ability to give plus-performance this year and for many years to come without needing attention, requiring only infrequent lubrication, maintaining their initial close tolerances and showing practically no wear.

You, too, can gain these advantages by only specifying SKF Bearings. For SKF always puts the right bearing in the right place.

4012

SKF INDUSTRIES, INC., PHILA., PA.

of the old, as well as the new, company—Thomas Foundries, Incorporated, are E. A. Thomas, President, and W. D. Webster, Secretary-Treasurer.

• LATEST CATALOGS

Synchro Diaphragm Control Valves

Describing their complete line of Synchro Diaphragm Control Valves, a new bulletin No. 461 has been recently completed by The Bristol Company, 21 Bridge Street, Waterbury, Conn. Information is given regarding the constructional features, the operating characteristics, and the various types of Bristol's Synchro Diaphragm Valves and their application to typical installations, where temperature, pressure, liquid level, flow and humidity are controlled pneumatically. Data on sizes, dimensions and valve metals are also included.

Industrial Compressors

A new bulletin on small Industrial Compressors and Vacuum Pumps has been recently issued by Ingersoll-Rand on their "Type 30" line, which ranges in size from 1/4 to 15 horsepower.

The bulletin, number 2118, gives complete rating tables of more than fifty models in this classification, including their physical dimensions and shipping weights as well as their capacities, pressures, and rated horsepowers. Copies of the bulletin are available from the Ingersoll-Rand Company, 11 Broadway, New York, N. Y., or any of their branch offices.

New Diamond Roller Chain Catalog

Inside the covers of the new Catalog 617, recently published for the Diamond Chain & Mfg. Co., 413 Kentucky Ave., Indianapolis, Ind., there are 96 pages of information on the use of roller chains for motor drives, machinery and conveyor applications. The engineering section, pages 4 to 33, includes new and additional data, tables, formulae, selection and installation information, much of which has never before been made available. Other sections cover dimensions and capacity tables for roller chain:—another is devoted to chain attachments as used for conveying and timing mechanisms, another deals with non-corrosive chains—and the last section describes sprockets with complete tables on standard sprocket diameters for various pitches of chain up to 2 1/2" pitch. This catalog is bound in substantial flexible cover designed to open flat for easy reference and use.

Welding Instructions

An attractively bound 81-page booklet entitled "Welding Instructions and Standards—Part I" has just been published by the United States Steel Corporation Subsidiaries. This brochure is the first of a series dealing with all phases of welding, and others will soon be issued. Among the subjects discussed in the new booklet are the symbols for fusion and resistance welding, specifications for individual welds, and a list of various types of welded joints. A useful feature of the booklet is a supplement wherein standard sections of welds, filler metal properties, workmanship and other subjects not directly connected with the section on welding symbols, are briefly treated so that Part I may be of the greatest service to those interested in welding.

Numerous illustrations showing welding technique and various welded products add to the value of the brochure. A typical form for welding drawings is also included, and an example is provided to show how much time and space are saved by the use of the new symbol system as against written instructions.

Copies of this valuable brochure may be obtained by writing to the United States Steel Corporation Subsidiaries, Box 176, 434 Fifth Avenue, Pittsburgh, Pa., or by applying to a district office of the Carnegie-Illinois Steel Corporation.

Bristo Socket Screw Products

Bristo Socket Screw Products, with the Multiple - Spline Design, are described in a new bulletin No. 835 recently published by The Bristol Company, 21 Bridge Street, Waterbury, Conn.

Complete information is given about these screw products: the wide variety of sizes—from wire-size as small as No. 4 up to 1 1/2 inches in diameter—and the prices applying. Some of their applications in machine design and building, as well as other useful data, are also included.

Hays Combustion Control System

The Hays Corporation, 1038 East 8th Street, Michigan City, Indiana, has just issued a 40 page brochure on Centralized Combustion Control for steam power plants. As a supplement, an 8-page pamphlet is being offered on the designing and manufacturing of boiler room panels. The two publications afford a most complete exposition of modern combustion control methods and are available to all who are interested in the subject.

J-M Industrial Friction Materials

In a new illustrated brochure, "Industrial Friction Materials," Johns-Manville, 22 East 40th St., New York, N. Y., has gathered together comprehensive data on the complete lines of industrial brake linings and blocks and clutch facings which it manufactures for all types of industrial equipment.

The most important feature of this brochure is a chart which simplifies the selection of the most suitable friction material for any specified service. On this chart are represented brakes and clutches of the disc, cone and band types. Listed down one side of the page are all of the factors which must be considered, such as rubbing speed, drum temperature, pressure, etc. If one knows the service conditions which must be met, he can look them up on this chart and, by glancing horizontally across the page, automatically pick out the correct friction material for his purpose.

Supplementing this technical chart is a second table which gives the coefficient of friction, size limits, thickness, tolerances and recommended service conditions for each of the various types of J-M Industrial Brake Linings and Blocks and Clutch Facings. Also listed are the tolerances on hole locations drilled with temporary template and permanent jib.

New Book on Hastelloy Alloys

A new 36-page booklet, "Hastelloy—High Strength Alloys for Corrosion Resistance," has just been published and presents complete information on the four Hastelloy alloys. Points covered in detail in this publication are chemical and physical properties, available forms, methods of fabrication, machining and welding, and typical successful applications of Hastelloy alloys. Penetration rates are tabulated for a number of the highly corrosive acids. Information concerning physical and mechanical properties and the available forms in which the materials are furnished will enable the designer of chemical plant equipment to make all necessary calculations for planning the most efficient use of the Hastelloy alloys in his equipment. Copies of this useful booklet are available from Haynes Stellite Company, Kokomo, Indiana, or from any of this company's district offices.

P & H Multi-Service Crawler Hoist

The Harnischfeger Corp., 4400 West National Ave., Milwaukee, Wis., announces the release of Bulletin X-39 entitled "P & H Multi-Service Crawler Hoist," which describes in detail the many features combined in this new general utility high-speed machine. With interesting job photos and line drawings, the many uses of the P & H Multi-Service Crawler Hoist are explained to bring home the many new advantages this machine brings the construction and maintenance fields. Condensed specifications are also included to complete data on this revolutionary machine.

Graph Sheet and Co-ordinate Papers

Keuffel and Esser Co., Hoboken, N. J., announce their new booklet-catalog on Graph Sheet and Co-ordinate Papers. This booklet contains an unusual amount of valuable information on its subject, and illustrates use of typical graph forms in a clear, concise manner.

COMING MEETINGS AND EXPOSITIONS

For the next three months

MARCH

7–11	American Society for Testing Materials, Regional Meeting, Rochester, N. Y.
9–12	American Society of Tool Engineers, First Annual Membership Convention and Machine & Tools Progress Exhibition, Convention Hall, Detroit, Mich.
15–17	American Railway Engineering Association, Annual Meeting, Palmer House, Chicago, Ill.
Wk. of 21	American Society for Metals, Western Metal Congress, Los Angeles, Calif.
23–25	American Society of Mechanical Engineers, Spring Meeting, Los Angeles, Calif.
Wk. of 28	American Ceramic Society, Annual Meeting, Roosevelt Hotel, New Orleans, La.
28–30	Society of Automotive Engineers, National Passenger Car Meeting, Hotel Statler, Detroit, Mich.

APRIL

Wk. of 17	American Society of Civil Engineers, Spring Meeting, Jacksonville, Fla.
18-19-20	American Gear Manufacturers Association, 22nd Annual Meeting, General Brock Hotel, Niagara Falls, Canada.
Wk. of 24	American Water Works Association, Annual Convention, New Orleans, La.

MAY

9–11	American Institute of Chemical Engineers, Semi-Annual Meeting, Greenbrier Hotel, White Sulphur Springs, West Virginia.
14–21	Tenth International Petroleum Exposition, Tulsa, Oklahoma.
Wk. of 14	American Foundrymen's Association, Annual Convention and Exhibit, Cleveland, Ohio.
23–25	American Petroleum Institute, Mid-Year Meeting, Wichita, Kansas.
26	American Iron & Steel Institute, General Meeting, Waldorf-Astoria Hotel, New York, N. Y.

The Standards COLUMN

News of Interest to Manufacturers

Brass Fittings for Flared Copper Tubes

For many years the usual construction for water service pipe has been lead pipe either plain or tin lined, iron, steel, cast-iron, or cement lined pipe, all requiring lead goose-necks for their connection with the corporation cock. The excessively corrosive action of water from within and of soil from without experienced in certain localities has increased the importance of the use of a pipe which will give the minimum amount of trouble from corrosion under each set of conditions.

Soon after the war copper and brass pipe in standard pipe sizes came into general use for water services demonstrating clearly their resistance to certain types of corrosion. Then, about ten years ago, flexible copper water tube using the compression type of fitting appeared in larger and larger quantities. How this use has spread is shown by the results of a survey recently concluded by the Copper and Brass Research Association. This survey indicates that 155 of the 200 cities in the United States having a population of 50,000 and more are at the present time permitting the use of copper tube for water service.

Flexible copper tube used with the corresponding brass compression fittings has other applications which meet certain needs of the engineer. For example, pressure and vacuum connections to indicating and recording instruments are conveniently made in this way.

The development of a standard for brass fittings for flared copper water tubes was initiated by a subcommittee of the Copper Tube and Fitting Manufacturers' Standardization Committee. This subcommittee, consisting of representatives of a group of firms producing cast-brass fittings, held several meetings during the years 1929 and 1930 which resulted in the development of a manufacturer's standard for this type of fitting.

Desiring to secure national recognition of its work, this committee, through its secretary, requested the Sectional Committee on Minimum Requirements for Plumbing and Standardization of Plumbing Equipment, A40, to include this project within its scope. This request was granted and new Subcommittee No. 7 on Brass Fittings for Flared Copper Tubes was organized. Sectional Committee A40 had been organized in August, 1928, under the procedure of the American Standards Association with the American Society of Sanitary Engineering and The American Society of Mechanical Engineers acting as joint sponsors.

The proposed standard for brass fittings for flared copper tubes (A40.2–1936) was widely distributed for general criticism and comment after approval by Subcommittee No. 7. It was subsequently approved by the Sectional Committee and later adopted by the sponsor organizations and submitted to the American Standards Association for final approval and designation as an American Standard. This designation was granted on January 20, 1936. For copies address the A.S.M.E. Publication Sales Department. Price 35 cents.

For further information—address
The American Society of Mechanical Engineers
29 West 39th St., New York, N. Y.